

Technology Education in Saudi Arabia in Comparison with New Zealand: A study of Policy, Curriculum and Practice in Primary Education

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Table of Contents

Declaration of Authenticity	xii
Acknowledgement	xiii
Dedication.....	xiv
Abstract.....	xv
Publications from this Research	xvi
Chapter 1.....	1
An Overview of the Research.....	1
1.0 Introduction	1
1.1 Preamble	1
1.2 Defining Terminology	2
1.2.1 Technology	2
1.2.2 Technology education.....	3
1.2.3 Information technology (IT)	3
1.2.4 Information and communication technology (ICT).....	4
1.2.5 Educational technology and instructional technology.....	5
1.3 Research Issue	8
1.4 Purpose of the Study.....	9
1.5 Significance of the Study.....	10
1.6 Research Aims.....	10
1.7 Research Questions.....	11
1.8 Organisation of the Thesis	11
1.9 Summary.....	12
Chapter 2.....	13
The Study Setting: New Zealand and Saudi Arabia	13
2.0 Saudi Arabia Context.....	13
2.1 Saudi Arabia (A Brief History)	13
2.2 Educational System in Saudi Arabia	14
2.2.1 Philosophy of the education system in Saudi Arabia and education policy	16
2.2.2 The Saudi national curriculum	17
2.2.3 Technology education in Saudi education.....	18
2.3 New Zealand Context (A Brief History)	19
2.3.1 The educational system in New Zealand.....	20
2.3.2 Philosophy of the education system in New Zealand and education policy	21

2.3.3 The New Zealand national curriculum	22
2.4 Cultural and Educational Differences between the Two Contexts.....	23
2.5 Summary	25
Chapter 3.....	26
Theoretical and Conceptual Framework.....	26
3.0 Introduction	26
3.1 Section 1: Underpinning Theory	26
3.1.1 Contextualising the study critically	26
3.2 Islamic Education	29
3.3 The Social Construction of Western Education: A Brief History	32
3.4 An Emerging Crisis in Education.....	34
3.5 The Economic Crisis	34
3.6 Education and Debt	36
3.7 The Elephant in the Room: Climate Change	37
3.8 Burning Fossil Fuels	37
3.9 Reducing Fossil Fuel Consumption.....	38
3.10 The Impact on Education.....	38
3.11 Summary.....	39
3.12 Section 2: Literature Review	40
3.12.1 The relationship between science and technology	40
3.12.2 Nature of science	42
3.12.3 Nature of technology	46
3.12.4 Nature of the relationship between science and technology.....	49
3.12.5 Ethics in science and technology.....	55
3.12.6 A framework for understanding the relationship between science and technology	56
3.13 International Technology Education	60
3.13.1 Technology education in the United States	60
3.13.2 Technology education in England	62
3.13.3 Technology education in Finland	63
3.13.4 Technology education in New South Wales, Australia.....	65
3.14 Technology Education in New Zealand	68
3.14.1 Key developments in technology education from 1995 to the present.....	68
3.14.2 The structure of the learning area in New Zealand	70
3.14.2.1 Technological practice.....	70
3.14.2.2 Technological knowledge.....	73
3.14.2.3 Nature of technology	74

3.15 Technology Education in the National Curriculum.....	75
3.15.1 Technology education in Saudi Arabia	75
3.16 Teachers' Perceptions of Science and Technology Education	80
3.16.1 Studies conducted in New Zealand	81
3.16.2 Studies conducted in Saudi Arabia	85
3.16.3 Studies conducted in other contexts	86
3.17 Implementing Technology Education in the Classroom	88
3.17.1 Modern strategies to technology education	88
3.17.2 Considering individual differences of students in the classroom	90
3.17.3 Technology education enhances authenticity and activity in classroom ..	91
3.17.4 Implementation technology education in the Saudi context.....	93
3.18 Key Findings from the Literature Review	94
3.18.1 The relationship between science and technology	94
3.18.2 National and international technology education curricula	94
3.18.3 Definitions and goals of technology education	95
3.18.4 Teachers' perceptions of technology education	95
3.18.5 Implementing technology education in classroom	96
3.19 Summary.....	97
Chapter 4.....	98
Research Methodology	98
4.0 Introduction	98
4.1 The Research Paradigm	98
4.1.1 Research approach	99
4.1.2 Research methods and instruments.....	100
4.1.2.1 Research design	100
4.1.2.2 Research strategy	101
4.1.2.3 Research questions	102
4.2 Procedures of Collecting and Analysing Data.....	103
4.2.1 Data collection methods	103
4.2.1.2 Documentary analysis.....	104
4.2.1.3 Interviews	105
4.2.1.4 Digital recording and photography	106
4.2.1.5 Classroom observations	106
4.2.1.6 Components of the observation sheet.....	107
4.2.1.7 Classrooms observed	111
4.2.1.8 Entering the field	111
4.2.1.9 Questionnaire	111

4.2.1.10 Questionnaire design	111
4.2.1.11 Questionnaire returns	114
4.3 Sampling	115
4.3.1 Sample selection process	116
4.4 Data Analysis Procedures	117
4.4.1 First phase of data analysis: Qualitative data	117
4.4.2 Second phase of data analysis: Quantitative data	118
4.4.3 Reliability and validity	119
4.4.3.1 Interviews	119
4.4.3.2 Questionnaires	119
4.5 Ethical Considerations	120
Informed and voluntary consent	120
Respect for rights of privacy and confidentiality	120
Minimisation of risk	121
4.6 Consistency and Comprehensiveness of the Study	122
4.7 Summary	122
Chapter 5	124
Findings of Two Studies Conducted in New Zealand and Saudi Arabia	124
5.0 Introduction	124
5.1 Phase 1: Findings of Study 1 in New Zealand	124
5.1.1 Documentary analysis findings	124
5.1.2 Identifying used documents and terms	124
5.1.2.1 National Education Goals (NEGS):	125
5.1.2.2 Foundation curriculum policy statements	126
5.1.2.3 National curriculum statements. These are statements of:	126
5.1.2.4 National standards	126
5.1.2.5 National Administration Guidelines (NAGs).	126
5.2 Technology education in the New Zealand curriculum	127
5.3 Classroom Observations and Findings	130
5.3.1 Preparation for classroom observation	130
5.3.2 Year 2 Classroom observation	130
5.3.3 First session	130
5.3.3.1 Aspect 1: General information about the observed class	130
5.3.3.2 Aspect 2: The learning environment	131
5.3.3.3 Aspect Three: Process of teaching and learning	133
5.3.3.4 Aspect 4: Indicators of progression of technology areas	135
5.3.4 Second session	136

5.3.4.1 Aspect 2: The learning environment	136
5.3.4.2 Aspect three: The process of teaching and learning	138
5.3.4.3 Aspect 4: Indicators of progression of technology areas.....	139
5.3.5 Third session.....	141
5.3.5.1 Aspect 2: The learning environment	141
5.3.5.2 Aspect 3: The process of teaching and learning	142
5.3.5.3 Aspect 4: Indicators of progression of technology areas.....	143
5.4 Year 6 Class Observation Findings	145
5.4.1 First session	145
5.4.1.1 Aspect 1: General information about the observed class	145
5.4.1.2 Aspect 2: The learning environment	146
5.4.1.3 Aspect 3: Process of teaching and learning	149
5.4.1.4 Aspect 4: Indicators of progression of technology areas.....	151
5.4.2 Session 2	152
5.4.2.1 Aspect 3: Process of teaching and learning	152
5.4.2.2 Aspect 4: Indicators of progression of technology areas.....	154
5.4.3 Session 3	155
5.4.3.1 Aspect 3: Process of teaching and learning	155
5.4.3.2 Aspect 4: Indicators of progression of technology areas.....	156
5.4.4 Session 4	157
5.5 Interview Findings	158
5.5.1 Participants' Backgrounds	158
5.5.2 Emerging themes from the interviews with technology teachers.....	160
5.5.2.1 Emerging theme 1: Teaching technology education engages students in design and modelling of authentic technological outcomes.....	161
5.5.2.2 Emerging theme 2: Tangible objects attract students in technology classroom	161
5.5.2.3 Emerging theme 3: Science and technology complement each other	161
5.5.2.4 Emerging theme 4: Technology education resources.....	161
5.5.2.5 Emerging theme 5: Current technology curriculum helped teachers in the classroom	162
5.5.2.6 Emerging theme 6: Technology education teachers face physical and financial issues faced by	162
5.5.2.7 Emerging theme 7: Lack of teachers professional development...	162
5.5.3 Emerging themes from the interviews with technology experts	163
5.5.3.1 Emerging theme 1: Teaching technology as a distinct discipline .	163

5.5.3.2 Emerging theme 2: The current concept reflects the entire concept of technology	164
5.5.3.3 Emerging theme 3: Different views of integrating technology education in the curriculum	164
5.5.3.4 Emerging theme 4: There is a gap between theory and practice need to be identified	165
5.5.3.5 Emerging theme 5: Suggestions for teaching technology education in Saudi Arabia	165
5.6 Summary	165
5.7 Phase 2: Findings of Study 2 in Saudi Arabia	166
5.7.1 Findings from documentary analysis.....	167
5.7.2 Science and technology education in the Saudi curriculum	168
5.8 Classroom Observations Findings	172
5.8.1 Year 5 classroom observation findings	173
5.8.1.1 Aspect 1: Learning environment	173
5.8.1.2 Aspect 2: Teaching and learning process	175
5.8.2 Year 6 classroom observation findings	178
5.8.1.3 Aspect 3: Learning environment	178
5.8.1.4 Aspect 4: Teaching and learning process	179
5.9 Interview Findings	181
5.9.1 Science Teachers' perceptions of technology education	181
5.9.2 Participants' backgrounds.....	182
5.9.3 Emerging Themes from the interviews with science and technology teachers	183
5.9.3.1 Emerging theme 1: Saudi teachers struggling to teach technology	184
5.9.3.2 Emerging theme 2: Tangible objects attract students in technology classroom	184
5.9.3.3 Emerging theme 3: Science and technology complement each other	185
5.9.3.4 Emerging theme 4: Technology education resources.....	185
5.9.3.5 Emerging theme 5: Less attention given to technology education	185
5.9.3.6 Emerging theme 6: Crowded curriculum and the absence of clear guidelines to teach technology	185
5.9.3.7 Emerging theme 7: Lack of teachers professional development in technology	186
5.9.3.8 Emerging themes from the interviews with technology experts ...	186
5.9.3.10 Emerging themes from the interviews with science and technology experts.....	186

5.9.3.11 Emerging theme 1: Different views of teaching technology education as a separate subject	187
5.9.3.12 Emerging theme 2: Technology education is embedded with science	187
5.9.3.13 Emerging theme 3: Different views about integrating technology education with other subjects	187
5.9.3.14 Emerging theme 4: Science and technology curriculum do not reflect the policy	188
5.9.3.15 Emerging theme 5: Suggestions for teaching technology education in Saudi Arabia	188
5.10 Findings From The Questionnaires	189
5.10.1 Science Teachers' perceptions of technology education	189
5.10.2 Perceptions of tutors at technology colleges	200
5.10.3 Perceptions of technology advisors at technology council in Makkah ..	206
5.11 Findings From Open-Ended Questions	213
5.11.1 Science Teachers' perceptions of technology education	213
5-11-1 -1 Emerging theme 1: The existing curricula do not help to develop technological literacy	213
5.11.1.2 Emerging theme 2: The appropriate method for including technology in the curricula	214
5.11.1.3 Emerging theme 3: Key aspects of technological literacy	214
5.11.2 Technology advisors' perceptions of technology education	215
5.11.2.1 Emerging theme 1: Developing technological literacy within the existing curricula	215
5.11.2.2 Emerging theme 2: The appropriate method of including technology in the curricula	216
5.11.2.3 Emerging theme 3: Key aspects of technological literacy	217
5-11-3 Tutors' perceptions of technology education	218
5-11-3-1 Emerging theme 1: Developing technological literacy within the existing curricula	218
5-11-3-2 Emerging theme 2: The appropriate method of including technology in the curricula	218
5-11-3-3 Emerging theme 3: Key aspects of technological literacy	220
5-12 Summary	220
5-13 Conclusions	227
Chapter 6.....	229
Discussion, Implications, Limitations, Recommendations and Conclusions	229
6.0 Introduction	229
6- Principal Implications and Recommendations of Research Findings	229
7- Study Limitations	229

8- Directions for Further Research	229
9- Conclusion.....	229
6.1 Key Research Findings	230
6.2.1 Technology education in the official documents of New Zealand and Saudi Arabia	232
6.2.2 Technology Education in New Zealand and Saudi Arabia classroom	237
6.3 Findings Gained from Interviews with Technology Education Teachers in New Zealand and Saudi Arabia.....	244
6.4 Findings from Interviews with Technology Experts in New Zealand and Saudi Arabia	247
6.5 Findings Gained from Survey Participants in Saudi Arabia.....	248
6.6 Principal Implications and Recommendations of Research Findings	251
6.6.1 Educational policy	251
6.6.2 Ideas for developing curriculum and pedagogy	252
6.6.3 Ideas for developing teachers' efficacy	254
6.7 Study Limitations	256
6.8 Directions for Further Research	257
6.9 Conclusions	259
References	261
Appendix 1	273
Appendix 2	274
Appendix 3	275
Appendix 4	276
Appendix 5A.....	277
Appendix 5 B.....	279
Appendix 5 C.....	292
Appendix 6	294
Appendix 7	301
Appendix 8	308
Appendix 9:	315
Appendix 10: Science textbooks content in primary education.....	319
Appendix 11:	333
Appendix 12:	334

List of Tables

Table 1.1	Summary of some terms related to Technology and technology education in New Zealand and Saudi Arabia education systems in alphabetical order	7
Table 2.1	The developed plan for primary schools subjects (boys and girls), including the number of sessions per week for each subject.....	16
Table 3.1	Summary of the differences between science and technology	48
Table 3.2	Content of Technology Education Model for K-12 in USA.....	58
Table 3-3	Characteristics of problem solving, design, and research.....	93
Table 4.1	Levels 1 and 3 of indicators of progression of technological practice strand. Source: Techlink (2010).....	108
Table 4.2	Response Rates.....	115
Table 4.3	Sample of New Zealand and Saudi contexts (qualitative phase).....	115
Table 4.4	Sample of the Saudi context (quantitative data).....	116
Table 5.1	Years and curriculum levels of New Zealand education.....	128
Table 5.2	Pseudonyms of the participants and their roles.....	157
Table 5.3	Summary of the number of technology topics in primary science textbooks, Terms 1 and 2.....	168
Table 5.4	Pseudonyms of the participants and their roles.....	180
Table 5.5	The influence of the technological revolution on education.....	189
Table 5.6	Positive aspects of including technology in primary curriculum.....	190
Table 5.7	Type of technological knowledge that students need to acquire.....	192
Table 5.8	Teaching technology and Saudi's economic development	193
Table 5.9	Building a bridge between students and society.....	194
Table 5.10	Ability of current primary curricula to enhance students' technological literacy.....	195
Table 5.11	Ability of current developed science and technology curricula to enhance students' technological literacy.....	196

Table 5.12	Science teachers' comprehension of technology education.....	197
Table 5.13	Influence of the technological revolution on curricula.....	199
Table 5.14	Positive aspects of including technology in the Saudi primary curriculum.....	200
Table 5.15	Benefits of teaching Technology to Saudi society and economy.....	201
Table 5.16	Technology in primary schools as a foundation for further technology learning.....	203
Table 5.17	The relationship between science and technology.....	204
Table 5.18	The technological revolution and curricula.....	205
Table 5.19	Positive aspects of including technology in the Saudi primary curriculum.....	206
Table 5.20	Benefits of teaching technology to Saudi society and economy.....	208
Table 5.21	Technology in primary schools as a foundation for further technology learning.....	209
Table 5.22	The relationship between science and technology.....	210
Table 5.23	Comparison of technology education at primary school level in New Zealand and Saudi Arabia.....	223

List of Figures

Figure 2.1	Education system in Saudi Arabia.....	14
Figure 3.1	Almutairi's model of the relationship between science and technology.....	54
Figure 3.2	Themes suggested by Fath-Allah (2006) to teach technology in an Arabic environment.....	78
Figure 4.1	Data collection and analysis process.....	103
Figure 4.2	Linking between elements of the study.....	121
Figure 5.1	Students drawing the design on the sheet.....	139
Figure 5.2	Students working to evaluate the design.....	140
Figure 5.3	The students sit around the teacher who introduces the project for them.....	147
Figure 5.4	Students were engaged in collaborative learning.....	149
Figure 5.5	Students listen to the teacher to learn how to programme the robot.....	151
Figure 5.6	Students work collaboratively to solve the problem (challenges).....	152
Figure 5.7	Students evaluate themselves according the challenges given to them.....	156
Figure 5.8	Students working in groups to discuss the topic.....	172
Figure 5.9	Model of a fan operated by solar energy that shows how solar energy is transferred into electricity.....	173
Figure 5.10	Students sit in groups while the teacher discusses the topic with them.....	177
Figure 5.11	Model of solar cells used to show students how solar energy works.....	177

Declaration of Authenticity

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: Abbad Almutairi on 02/09/2015

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Dedication

*This work is dedicated to
My Mother and my Father
My wife Haifa Mohammad Abed
My children Asayal, Omar, Yazeed, Jood, and Malak
For their unfailing love, support, and prayers throughout the course of this thesis
May God bless you all*

Abstract

Over the past 25 years, Technology Education has been present in global curricula. It aims to prepare students to cope with the 21st Century where industrial and technological products dominate international economies. Technology Education has been taught either as a separate subject or integrated with other subjects, particularly with Science, and has been perceived as an area of learning combining knowledge and innovation.

This research sought to obtain deeper insight into technology education implementation in New Zealand and Saudi Arabia in order to explore how this subject is implemented in both contexts that leads to identification of the similarities and the differences between them. The findings of this research could help to promote and enhance teaching science and technology in the Saudi primary education. A qualitative approach was used as a main approach supported by a qualitative approach in the Saudi context to obtain rich data on the status quo of technology education in the two countries. Data were obtained from documents analysis, interviews with technology teachers and technology experts, observations of practice, and questionnaires.

The findings indicate that technology education has become one of the key subjects in developed countries. This has pushed New Zealand to make a good progress in implementing technology education in its curriculum by establishing a suitable strategy to include this subject in the curriculum. In Saudi Arabia, technology education has not been clearly defined and it has been implicitly integrated with science subjects. Therefore, there were significant differences in implementing the two subjects in both contexts particularly in terms of practice. Limited similarities between them were also found in this research.

Publications from this Research

- 1- Almutairi, A., Everatt J., Fox-Turnbull, W., Snape. and P. (2013) *Perceptions of Technology Education in the Saudi primary curricula (Tertiary students and Primary Science Teachers)*. Christchurch, New Zealand: PATT 27 Technology Education for the Future: A Play on Sustainability, 2-6 Dec 2013. In PATT 27 Technology Education for the Future: A Play on Sustainability 11-18. (Conference Contributions - Papers in published proceedings).
- 2- Almutairi, A., Everatt, J., Davis, N. and Snape, P. (2011) Technology Education in primary schools of New Zealand and Saudi Arabia: A comparative study. Dunedin, New Zealand: Biennial Conference of Technology Education New Zealand (TENZ 2011), 26-28 Jul 2011.
- 3- Almutairi, A., & Everatt, J., & Snape, P., & Fox-Turnbull, W. (2014). Exploring the relationship between science and technology in the curriculum. *Australasian Journal of Technology Education*, 1 (1), 49-63.

Chapter 1

An Overview of the Research

1.0 Introduction

This research investigates the status quo of technology education in the national curricula of New Zealand and Saudi Arabia. In so doing, it contributes to the international literature on the situation of technology education in certain countries. I conducted two studies. The first explored how technology education is implemented in New Zealand primary schools. The second study was conducted in Saudi Arabia, where education is segregated, investigated how technology education is implemented in the nation's primary curriculum for boys. These studies were followed by a comparative study that explored the similarities and the differences between the two countries, which could help to inform technology education in Saudi primary schools and develop the concept of technology education in the Saudi curriculum.

1.1 Preamble

The considerable technological, economic, social and cultural changes in recent years have led many countries to review their governmental systems in order to meet these changes and a new era of technological revolution. In many countries, education in general has been a top priority. Since 1990, technology education has emerged as an area of study in such countries such as Australia, the United Kingdom, the United States, Canada, South Africa and New Zealand, which have set this concept "within the historical, cultural, and political environment" (Jones, 2009, p. 13). Saudi Arabia has made significant moves towards educational reform, especially in terms of curriculum development. It has been trying to move from the list of developing countries to join the developed countries. To this end, the Ministry of Education in Saudi Arabia has launched a development plan that includes goals in a range of educational aspects to ensure that Saudi students can receive valuable learning. One of these goals is to help teachers and supervisors to develop their ability in teaching and learning as part of their professional development (Ministry of Education, 2009a). To put this goal into practice, many teachers and supervisors in different subjects and from different regions, including myself, were chosen by the Saudi Ministry of Education to continue professional development internationally. I believe that

conducting this study will help me to understand how technology education exists and is implemented in international curricula, and will also help to develop technology education in Saudi primary schools. I begin this study by defining certain educational terms, in an attempt to remove any ambiguity.

1.2 Defining Terminology

There has been a degree of argument and misunderstanding among educators regarding some educational concepts. For instance, I was initially confused about the difference between the terms “educational technology” and “technology education”. However, after reading about all these concepts in both Arabic (Arabic refers to the mother language of the Arab peoples who originated from the Arabian peninsula and neighbouring territories, but who now inhabit much of the Middle East and North Africa) and Western literature (Western means in this thesis Europe, as well as many countries of European colonial origin with substantial European ancestral populations in the Americas and Australia and New Zealand), I acquired better definitions of these concepts. These definitions are required in order to understand how these terms are defined in the New Zealand and Saudi Arabia contexts in order to remove any ambiguity that could cause misunderstanding to the reader. My experiences in education in Saudi Arabia, both as a supervisor of instructional technology and as a director of curriculum development at the Educational Directorate in Almahd province, and in New Zealand as a postgraduate student, have helped me identify, discuss and define seven concepts in the following sections. These concepts are summarised in Table 1.

1.2.1 Technology

In New Zealand, the Ministry of Education (2007a) defines ‘*Technology*’ as:

intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative. Technology makes enterprising use of its own particular knowledge and skills, together with those of other disciplines. Graphics and other forms of visual representation offer important tools for exploration and communication. Technology is never static. It is influenced by and in turn impacts on the cultural, ethical, environmental, political, and economic conditions of the

day. (p.32)

Technology refers to the separate subject of technology as it is taught in New Zealand schools.

There are a few Arabic references that define technology. In Saudi Arabia, the popular definition of technology mentioned by most Arabic educators is that technology refers to a Greek word that consists of a prefix, “techno” meaning handcraft, and the root (or suffix) “logy”, which means knowledge. Therefore, the combination of these words means “craft knowledge”, so technology refers to a systematic application of scientific knowledge for practical purposes (Hendawi, Ibrahim, & Mahmood, 2009). Although the definition of technology in New Zealand is more generic, there is no major difference between the two definitions in the two contexts.

1.2.2 Technology education

‘*Technology education*’ refers to the theoretical foundations that guide technology teachers. In the New Zealand curriculum, the Ministry of Education (2007a) has instructionally designed and identified three components of technology education: Technological practice, technological knowledge and nature of technology (p. 32). Generally, technology education is defined as “A planned process designed to develop students’ competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of technological society” (Ministry of Education, 1995, p. 7).

Technology education in the Arabic context was defined by Fath-Allah (2006) as a discipline that focuses on teaching technology as a human activity including control systems and their basic elements, which include tools, materials, knowledge, skills, people, power, time and funding.

1.2.3 Information technology (IT)

In New Zealand, the Ministry of Education (2004) defined information technology as “the term used to describe the items of equipment (hardware) and computer programmes (software) that allow us to access, retrieve, store, organise, manipulate, and present information by electronic means. Personal scanners and digital cameras fit into the

hardware category; database programs and multimedia program fit into the software category” (p. 5).

On the other hand, the definition of Information Technology used by UNESCO (the United Nations Educational, Scientific, and Cultural Organization) (UNESCO, 2002) has been commonly used by many Arab writers, including Saudi authors, as applying to electronic technologies such as computers and satellites, etc. that help to produce, store, exchange and distribute digital information (Salem & Saraya, 2003). Therefore, there is no real difference between the definitions of the term in the Western and Arab contexts.

1.2.4 Information and communication technology (ICT)

The New Zealand Ministry of Education (2006) stated that ICT “includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning” (p. 9).

In addition, another term in New Zealand is sometimes linked to ICT. This term is electronic learning (e-Learning). The Ministry of Education (Ministry of Education, 2009b) defines this term as:

Learning that is enabled or supported with the use of information and communication technologies (ICT). E-Learning typically involves some form of interactivity, including online interaction between the learner and their teacher or peers. E-Learning opportunities are usually accessed via the Internet and its associated tools and software. However, e-Learning is evolving to include an increasing use of a wide and diverse range of other technologies and tools. These include video- and audio-conferencing, mobile phones, data projectors, digital cameras, global positioning systems and interactive whiteboards.

In the Arabia context, ICT was defined by Masaa (1999) as:

a set of technologies, tools, means, and the various systems that are employed to address the content that is intended to be delivered through a process of mass communication, personal, organisational, and by which the collection of information that exist in different forms: audio, written, picture, drawn, audio-

visual, printed, and digital by electronic computing. This information will be stored, retrieved, and exchanged from one place to another in a timely manner through manual, mechanical and electronic means (p. 26).

1.2.5 Educational technology and instructional technology

Educational technology has been defined by many Western writers, most of whom share the same idea about defining this concept. Luppicini (2005) defined it in general as “the field concerned with the design, development, utilization, management, and evaluation of processes and resources for learning” (p. 108). Luppicini also defined educational technology within a society as:

a goal-oriented problem-solving systems approach utilizing tools, techniques, theories, and methods from multiple knowledge domains, to: (1) design, develop, and evaluate human and mechanical resources efficiently and effectively in order to facilitate and leverage all aspects of learning, and (2) guide change agency and transformation of educational systems and practices in order to contribute to influencing change in society. (p. 104)

Gentry (1995) defined instructional technology as a subset of the educational technology since educational technology encompasses instructional, learning, developmental, and managerial technologies.

Arabic literature emphasises that many educators do not differentiate between instructional technology and educational technology; instead, the two terms are used synonymously, which simply means using technologies such as overhead projectors, TV, and videos in teaching (Alhelah, 2001). Alhelah (2001) attributed this usage to the fact that “instruction” and “education” have distinct meanings in Arabic. The term “instructional technology” means a purposive design for the experiences that help the learner achieve the desirable change of the performance; and it is also a learning administration that is led by a teacher within the classroom. The second term, “educational technology,” is concerned with education to analyse an administrative coordination of education, which will then help to develop education and educational management together, because the process of discovering, analysing, and attempting to find suitable solutions for problems exactly match with a function of educational administration (Alhelah, 2001).

1.2.6 Technological literacy

In New Zealand, technological literacy is an overall aim of technology education, as mentioned in Technology in the New Zealand Curriculum (Ministry of Education, 1995b), which is to help students “to achieve technological literacy” (p. 8). According to the Ministry of Education (2007a), technology education is essential in order to achieve technological literacy through teaching these three strands that will be discussed in more detail in chapter three:

- Technological practice
- Nature of technology
- Technological knowledge

In Saudi Arabia, some authors (Hendawi, et al., 2009; Fath-Allah, 2006) have explained *technological literacy* as the way that technology aims to help learners understand technological developments and innovations and to practice them in their daily lives. The definition of technological literacy is more specific and structured in the New Zealand curriculum.

Table 1.1: Summary of some terms related to Technology and technology education in New Zealand and Saudi Arabia education systems in alphabetical order

Terms	New Zealand and Western contexts	Saudi Arabia contexts
Educational Technology (ET)	Technologies used to improve educational system that influences society by applying tools, techniques, theories, and methods from multiple knowledge domains.	Technologies used in different educational purposes in a generic educational system, especially with educational administration functions.
Information Technology (IT)	Using communication technology (CT) such as phones, faxes, modems, and computers to access, retrieve, store, organise, manipulate, and present information.	Produce, store, exchange and distribute digital information using such electronic technologies as computers, satellites, etc.
Information Communication Technology (ICT)	Includes any communication device or application, including radio, television, cellular phones, computer and network hardware and software, satellite systems, etc., as well as the various services and applications associated with them, such as videoconferencing and distance learning.	A set of technologies that are employed to address the content that is intended to be delivered through a process of mass communication (both personal and organisational process), and by which information and data (audio, written, pictorial, drawn, audio-visual, printed, and digital) is collected by electronic computing; and then stored, disseminated and exchanged from place to another in a timely manner using manual, mechanical and electronic ways that depend on the historical development of ICT.
Instructional technology	A subset of the educational technology in which teachers use educational technology within the classroom.	A subset of the educational technology in which teachers use educational technology within the classroom.
Technology	A separate subject that includes sub-subjects: biotechnology/food technology/ ICT/structural /control/digital technology.	Embedded in science and arts. This means the subject has not been defined but there some technological topic taught in science and arts.
Technology education	Presents the philosophy of teaching technology: Technological practice/technological knowledge/nature of technology.	A discipline that focuses on teaching technology as a human activity including control systems and their basic elements, which include tools, materials, knowledge, skills, people, power, time and funding.
Technological literacy	The overall aim of technology education. Consists of: <ul style="list-style-type: none"> • Technological practice • Nature of technology • Technological knowledge 	Helps students to understand technological developments and innovations and to practice this information while they use technological devices and materials in their daily lives.

1.3 Research Issue

Technology education is a modern subject that has had its own philosophy in the curricula of some countries since 1980. De Vries (2006) explained that “the actual process of technology education evolutions differs from one country to another” (p. 4). De Vries divided the countries that teach technology education into four categories, based on the subject’s movement over the past 20 years. In some countries, it seems that there has not been much progress. For example, technology education in Switzerland, Australia, and some Scandinavian “looks very much the same as the situation of 20 years ago” (De Vries, 2006, p. 4). Malta and Scotland are among the second category, which represents a period of circular movement; that is, a period of back-and-forth progress. The third category includes countries in which there has been a debate about the situation of technology in the curriculum. For instance, the governments of France and the Netherlands have been considering three ways of dealing with this subject: should they keep technology education as a separate subject, should it be integrated with better-established subjects such as science, or should it be neglected? The fourth category is where there has been a continuous development of technology education in terms of teaching and research, such as in the United States, New Zealand, England and Wales.

This subject has not been clearly defined in the national curricula of other countries and it has been embedded within science subjects, such as certain Arab countries including Saudi Arabia. I suggest that this represents a fifth category in terms of the situation of global technology education, to add to the four identified by De Vries. In Saudi Arabia, there is a lack of understanding of technology education among educators and curriculum developers, despite some technological topics being taught within other science subjects. Technology education in these countries has not been clearly defined and it has been implicitly embedded in the curriculum. In addition, no debate has been raised, either by educationalists or politicians, regarding the inclusion of this subject within the curriculum or a discussion of the relationship between science and technology. However, this situation should not lead us to suggest that the Saudi educational policy (Ministry of Education, 1995a) has neglected the importance of teaching students practical skills that reflect the concept of technology education. This concept is one of the objectives of science in primary education, as mentioned in the introduction of some science textbooks. These aspects will be further discussed in Chapter 5, where the study’s findings are represented.

In the current technological era, countries need to think about teaching technology education in schools by exploring what is happening in that field. Pavlova (2005) emphasised the importance of knowing about “what has been happening in a particular area over a particular period of time [which] can provide a valuable reflection on how a phenomenon is being developed, what issues have been addressed and how it is possible to proceed in the future” (p. 19).

1.4 Purpose of the Study

The purpose of this study is to overcome the problem resulting from the absence of the concept and the clear content of technology education in Saudi primary education. This can be achieved by analysing the situation of technology education in the national and international contexts (New Zealand) to explore the similarities and differences between technology education in Saudi primary education and international primary education. The results of the analysis would assist in the conceptualisation of technology education in Saudi to be a part of the educational reform in that country. Therefore, the overall aim of this study was to explore how technology education is structured and implemented in one of the New Zealand primary schools in Christchurch City. This school was considered by technology education experts in Canterbury District as a good example of teaching this subject. The technology education experts teach technology education at Canterbury University, are involved in a range of responsibilities related to technology education, have published many articles regarding technology education, and are key members of Technology Education Association in New Zealand. They indicated that this school has been teaching this subject for almost 10 years. They visited the school several times and have worked with technology education teachers to develop teaching this subject in this school to ensure that technology education is implemented in an effective way in the classroom.

Another aim was to explore how technology education is structured and implemented in Saudi Arabia. The results of both studies and their comparisons enabled me to suggest some recommendations to improve technology education in the Saudi primary curriculum. These recommendations included how the concept of technology education can be developed in the Saudi primary curriculum.

1.5 Significance of the Study

The importance of this study stems from its contribution to knowledge, particularly its contribution to support future development technology education in the educational system in Saudi Arabia. After analysing the data, it is hoped that the results of this study will:

1. Provide Saudi educators with a new understanding of the current situation of technology nationally and internationally (with New Zealand as an example);
2. Provide the Ministry of Education (MoE) in Saudi Arabia with new information and issues relating to science and technology education that it should consider when addressing future educational policies and educational reform;
3. Lead to further in-depth research on science and technology education, both nationally and internationally;
4. Offer insights into participants' views on probable/preferable future of teaching technology education. This will inform policy makers about the possible ways of teaching technology education in primary education; and.
5. Open the way for more research on the future of education in the Saudi in general and of science and technology in particular.

1.6 Research Aims

The research has the following aims.

1. To explore how technology education is implemented in the New Zealand primary curriculum;
2. To explore the current situation of technology education in the Saudi primary curriculum;
3. To explore the similarities and differences between technology education in the New Zealand primary curriculum and science and technology in the Saudi primary curriculum;
4. To inform the Saudi context of the new streams of teaching technology based on the New Zealand experience; and
5. To introduce some recommendations to improve technology education in the Saudi context.

1.7 Research Questions

In order to address the aims of this research, this study seeks to answer the following principal question and sub-questions.

How can the experience of New Zealand's implementation of technology education inform the technology education in the Saudi curriculum?

1. How is technology education implemented in the New Zealand primary curriculum?
2. What is the current situation of technology in Saudi primary education?
3. What are the similarities and differences in technology education in both contexts?
4. What could improve the teaching of technology education in the Saudi primary education?

1.8 Organisation of the Thesis

This thesis consists of six chapters.

Chapter 1 provides an introduction, preamble, identifying terminology, research issues, and the purpose of the research, the significance of the study, research aims and questions. The structure of this thesis is also presented.

Chapter 2 describes the study, setting out in detail the terms of the social, cultural and educational situation.

Chapter 3 provides an historical framework, including reviewing the literature in respect of the research questions.

Chapter 4 describes the research design and methodology.

Chapter 5 presents the research results.

Chapter 6 includes discussion, implications, and conclusions.

1.9 Summary

This chapter has provided an introduction to the research study. The next chapter will focus on the research setting.

Chapter 2

The Study Setting: New Zealand and Saudi Arabia

The previous chapter provided an overview of this study. In this chapter, the focus will be on the two contexts of the study in terms of their history, culture and religion, as well as their educational systems. New Zealand and Saudi Arabia have cultural, religious and educational differences that influence education in both contexts. For example, New Zealand is a secular country where religion does not play any role in shaping New Zealand education and culture while Islam is the religion that dominates education and culture in Saudi Arabia. Moreover, classes in New Zealand are mainly mixed gender (co-education) while in Saudi Arabia they are all single sex. Such differences need to be clarified in this thesis to provide a better understanding for the reader of the factors that need to be considered when we discuss educational issues in both contexts. There are 1,077 New Zealand full primary schools (years 1 to 8), according to 2015 statistics (Education Counts, 2015), while the total number of Saudi primary schools (years 1 to 6) is 13,678, according to 2013 statistics (Ministry of Education, 2013). This section will provide brief information about the history of the two countries and will discuss some of the educational, cultural, and religious issues. In this chapter I will also justify why New Zealand was selected as an appropriate model to inform the Saudi context.

2.0 Saudi Arabia Context

This section provides information about Saudi Arabia's history and educational system. This section includes some aspects that shape education in Saudi Arabia: its history, education system, philosophy of the education system, and the curriculum.

2.1 Saudi Arabia (A Brief History)

Saudi Arabia (officially, the Kingdom of Saudi Arabia) was unified by King Abdulaziz in 1932. It occupies most of the Arabia Peninsula, with the Red Sea and the Gulf of Aqaba to the west and the Arabic Gulf to the east. It is the largest country in the Middle East and is also the world's leading exporter of petroleum (Alothimen, 2004, p. 13). Saudi Arabia is bordered by eight Arabic countries: Jordan, Iraq, Kuwait, Qatar, the United Arab Emirates, the Sultanate of Oman, Yemen, and Bahrain. Saudi Arabia contains the world's largest

continuous sand desert, the Rub Al-Khali, or Empty Quarter (Alshareef, 2007). The kingdom is sometimes called “The Land of the Two Holy Mosques” in reference to Almadinah and “Makkah” [“Mecca” in English]. The latest population statistics in 2014 shows that the population of Saudi Arabia was 30.7 million, of which 20.7 million were Saudi nationals and 10 million non-nationals (Central Department of Statistics and Information, 2014). Saudi Arabia comprises 13 administrative areas, each of which consists of a number of governorates and a bigger number of administrative districts with Riyadh as the capital (Twal, 2010).

2.2 Educational System in Saudi Arabia

Education in Saudi Arabia is a main target for national investment and development. Since the kingdom was unified in 1932, the Saudi government has devoted considerable attention to education. In fact, the first Department of Education was established in 1925 – seven years before the kingdom was finally established. In 1953, the Ministry of Education was established. Despite the difficulties that the Saudi government faced in terms of disseminating education throughout a nation of 2.1 million square kilometres, including a difficult geography that consists of huge deserts and high mountains, there has nevertheless been a very strong determination to teach and educate Saudi students in every corner of the kingdom. For example, the number of primary schools (boys and girls) jumped from 1740 in 1970 (Alsunbl, Alkhateb, Motoaly, & Abduljawad, 2008) to 12,384 in 2007 (Ministry of Education, 2007c). The latest statistics from the Ministry of Education (2009d) indicate that the total number of schools (kindergartens, primary, intermediate, secondary, special needs schools and afternoon schools) is 33,469. According to the same source, the total number of students was 4,815,907 and the total number of teachers was 467,849.

The education system consists of several stages, starting with kindergarten and concluding (in some cases) with a high degree (a doctorate). Education is compulsory for all Saudi students: when a child turns six, he or she must start attending school. Alhamed, Zeyadah, Alotaibi and Motawli (2007) included a diagram that illustrates the Saudi education system and includes all main types of education (p. 85) (see Figure 2.1 for a simplified version). This figure shows the educational stages and the number of years of each stage.

Figure 2-1 shows that the education system in Saudi Arabia consists of a number of different stages of learning for both boys and girls (segregated education), beginning with the primary stage. This stage lasts for six years from when a pupil begins school. The intermediate level is for three years and then, normally, high school is for three years. Both genders can then continue their education at the tertiary level; a first degree usually takes four years but may be longer depending on the area or major the student has opted for. Postgraduate, higher education includes Master's level, which takes about two years, and doctoral study of four years or more. There are also many institutions and colleges available that provide students with opportunities to engage in fields of technical work, industry, commerce, or medicine. This study focuses on the primary stage.

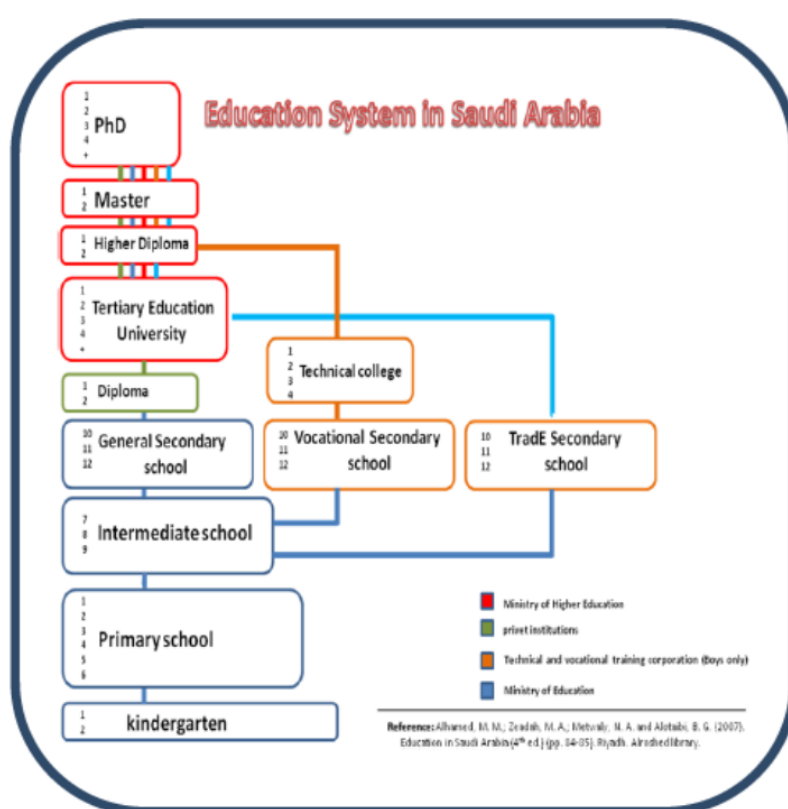


Figure 2.1: Education system in Saudi Arabia

Adopted and updated from Alhamed, M., Zeyadah, M., Alotaibi, B. & Motawli, N. (2007). Education in Saudi Arabia: Vision to present and predicting the future (4ed.). Riyadh: Alrushd Library. (p.85)

2.2.1 Philosophy of the education system in Saudi Arabia and education policy

Any educational system derives its philosophy from the philosophy of its society that includes beliefs, attitudes and traditions that differ from one society to another. It also depends on the mainstream educational theories that underpin teaching and learning in that society. Alsunbl et al. (2008) explained that a system philosophy includes factors that shape the objectives of the educational system, its principles and the circumstances that form its content. Thus, education in Saudi Arabia has its own philosophy that has been shaped by four fundamental factors, which are explained briefly below.

The first factor is the Islamic religion, which plays a key role in shaping the education philosophy in Saudi Arabia. People in Saudi Arabia believe in Allah as God and in His messenger Mohammed as prophet. The Qur'an, which is the holy book, is a guide for community life in Saudi Arabia and is the main resource of education at all stages of learning.

The educational policy is the second factor. This policy has been formulated by the High Committee of Education Policy and it includes the principles of this policy, the main goals of education, the general objectives of education, and the objectives of the educational stages. Many resources constitute the educational policy in Saudi Arabia: the national characteristics, attitudes and beliefs, historical experience, foreign experience and educational thinking (Alsunbl et al. 2008).

The third factor is the Arabic language, which is also the language of the Quran and the official language in Saudi education. Hence, keeping it alive is a very important goal in Saudi education. All subjects (see Table 2.1) are taught in Arabic language and there are six 'Arabic' subjects: writing, reading, dictation and grammar (primary, intermediate and high schools), expressive writing (primary, intermediate, and high school intermediate) and poetry (intermediate and high schools).

The fourth factor that influences the content of education in Saudi Arabia is Islamic culture. Some subjects include several topics about Islamic civilisation and they provide students with information about the contributions of Arabs and Muslims in all branches of knowledge.

Finally, oil is at the top of the economic factors that impact on the educational system in this country. This natural resource has helped the Saudi government to maintain its role to develop its educational systems in different aspects. Al-Mikaimzi (2008), the chief of public relations in the Ministry of Education, revealed that Saudi Arabia has allocated about 9 billion Saudi Riyal (SR) for the Tatweer project (Tatweer means “development” in Arabic) (King Abdullah Public Education Development Project) and is planning to take education into the modern era as a response to the global scientific and economic revolution. Al-Mikaimzi explained that the project consists of four aspects: developing teachers’ skills, developing curricula, enhancing school activities and improving the school environment. Moreover, the Ministry of Education (2009c) said that the Tatweer Department has identified programmes that will be enhanced and developed during this project. Tatweer aims to enhance education: curriculum and learning materials, learning environment, teachers’ training and professional development and promotion of extra-curricular activities.

2.2.2 The Saudi national curriculum

The National Curriculum is an official document that includes all subjects taught in Saudi schools with their objectives and syllabus content. However, each subject has its own document and no document has yet combined all subjects. In December 2012, I visited the Ministry of Education and met some decision-makers who provided me with the latest update on the national curriculum, including names of subjects that will be taught in schools. Table 2.1 lists 12 primary school subjects because the present study focuses on this stage (years 1–6) in boys schools.

Table 2.1: The developed plan for primary schools subjects (boys and girls), including the number of sessions per week for each subject.

No	Subjects	Years					
		Year 1	Y 2	Y 3	Y4	Y 5	Y 6
1	The Holy Quran	7	7	7	6	4	4
2	Monotheism	1	1	1	1	1	1
3	Topics in Behaviour	1	1	1	1	2	2
4	Arabic language (writing, reading, and expression and wording)	11	9	9	8	8	8
5	Mathematics	3	5	5	5	5	5
6	Science	2	2	2	2	3	3
7	Arts and occupational education	2	2	2	2	2	2

8	Physical education	3	3	3	2	2	2
9	Home economics for girls	3	3	3	2	2	2
10	Prophet's autography	0	0	0	2	2	2
11	Social and citizenship education	0	0	0	2	2	2
12	English language	0	0	0	0	0	2

Source: General Department of Curriculum Development (Ministry of Education, 2009a)

Before this plan of subjects is discussed, it is important to mention that it has been developed by the General Department of Curriculum Development at the Ministry of Education and also according to the recommendations of educational leaders during their 18th meeting, which was held in Makkah Region from 3–6 June 2009 (Ministry of Education, 2009c). One of the leaders' recommendations was that new subjects be included in the national curriculum, although no clear details of these new subjects were provided, such as their names, goals, learning stages, their content or their theoretical foundation. However, the General Department of Curriculum Development has identified some of these subjects. I would argue that this plan has not included a major development that can be mentioned, apart from adding the name of a new subject, "occupational education," to subject number 7. I also assert that there are additional issues in relation to this subject, which will be discussed in the following section.

2.2.3 Technology education in Saudi education

Table 2.1 shows that technology education in Saudi schools has not been included as a separate subject in the Saudi curriculum and has instead been taught under the umbrella of science by teaching students some technological topics. For example, boys in primary education students are taught about such technological innovations as computers, mobiles, and hydraulic systems; these are understood by most teachers as scientific topics and connected to science subjects only. In my view, this mixing is caused by the absence of technology education (as a concept and theoretical framework) and technology as a major subject in Saudi curriculum that would help teachers, students and parents to recognise principles of science and technology and the relationship between both concepts. Table 2.1 also shows that girls are given more opportunity to learn about technology by involving them in home economics subject that includes food and sewing areas.

However, the educational leaders, during their 18th meeting in Makkah (Saudi Arabia), recommended that new subjects with professional characteristics be introduced to the Saudi curriculum (Ministry of Education, 2009c). I found that 'occupational education' is

the appropriate English term that matches the Arabic term (Alkhuli, 2001, p. 326). As mentioned earlier, the recommendations did not provide any interpretation of this statement, which has led educators to interpret the statement in different ways. For example, some may understand this statement based on its Arabic meaning, in the sense that these subjects must be included to help students improve their skills in crafts; for instance, students can design tangible things that help them develop their understanding about some technological products. Some educators understand it as thinking skills, which can be taught across other subjects. This interpretation was indicated by the director of the Department of Curriculum Development at the Ministry of Education when he discussed this issue with me. Thus, I can confirm that there is no clear explanation of the above-mentioned statement; this point will also be discussed as a major point in the research problem section.

2.3 New Zealand Context (A Brief History)

New Zealand was settled by Māori (the indigenous people of New Zealand) who are believed to have arrived between 800 and 1000 years ago. The modern history of New Zealand started in 1769 when the British navigator James Cook arrived to explore the New Zealand coastline. This was over a century after the Dutch voyager Abel Tasman had “discovered” New Zealand in 1642, although Tasman did not land in New Zealand due to an armed encounter with the Māori. From the late 1790s, whalers, traders and missionaries arrived in New Zealand and they established settlements along the coastline (New Zealand in History website, 2010). The conflicts between the Māori and foreigners who tried to occupy their land continued until 6th February, 1840 when the Treaty of Waitangi was signed by about 40 Maori chiefs and the British Crown. This treaty includes four principles: “the principle of active protection, the tribal right to self-regulation, the right of redress for past breaches, and the duty to consult” (Treaty of Waitangi website, 2010).

New Zealand is located in the South Pacific Ocean, 2,162 km from Australia, and is a long, narrow, mountainous land. Today it is an independent and democratic country and is also a member of the British Commonwealth. According to the latest statistics, New Zealand’s population is 4.35 million (National Statistical Office, 2015) and “that population is estimated to increase by one person every 8 minutes and 44 seconds”. Its total area is 268,670 square kilometres (Encyclopaedia of Nations, 2010).

2.3.1 The educational system in New Zealand

The New Zealand Government (2009) articulated that education in New Zealand follows a three-tier system – early childhood, schooling (primary and secondary levels) and tertiary education at universities. Education is compulsory for all students between the ages of six and 16, although most students commence school at age five. New Zealand has 2600 schools and it provides free education at primary and secondary level to its citizens and for those who are given permanent residence. The education system for New Zealand schools consists of 13 levels and “both single-sex and co-educational secondary schooling are available and state schools are secular” (New Zealand Government, 2009, p. 13).

There are 16 types of schools in New Zealand (Ministry of Education, 2009e). For the purpose of this study, the five common types identified by the New Zealand Government (2009) are as follows:

- State schools: The majority receive government funding and accept both genders.
- Independent or private schools: They charge fees but also receive some funding from the government. They do not have to follow the New Zealand Curriculum. There are over 100 schools of this type.
- State integrated schools: These were private schools but have now converted to the State system. Besides teaching the New Zealand Curriculum, they teach a philosophy related to certain religious beliefs. They receive funding from the government but their building and land are owned by the school’s owners.
- Boarding schools: Students live in the school during the term. This provides students with time and facilities to develop different skills in sporting and social life.
- Special needs schools: For students with special education needs, such as impairments, learning and behavioural difficulties.

All education sectors – early childhood, primary and secondary – are under the auspices of the Ministry of Education, which has “responsibility for strategic leadership, policy development and has a substantial operation role The Ministry of Education role in the tertiary sector is focused on leadership and setting direction, stewardship and governance and monitoring and evaluation” (National Education Information centre, 2015).

2.3.2 Philosophy of the education system in New Zealand and education policy

The Ministry of Education in New Zealand is proud to offer an education system that considers the diversity of cultures within the New Zealand community (New Zealand Government, 2009). The country's education system "recognises different abilities, religious beliefs, ethics groups, income levels" (p. 9). The Ministry is the central government organisation responsible for leading the education sector to prepare students to be successful in the 21st century by providing them "with the knowledge, skills and values to be successful citizens" (p. 6).

New Zealand is a secular country: teaching religion is not amongst its strategic goals. The Human Rights Commission (2009) indicated that "The Education Act 1964 (Section 77) affirms that teaching in primary schools is to be secular" (p.7). However, under the same Act, the Ministry of Education allows primary schools "to provide instruction and religious observance, but under certain conditions" (p. 6). In terms of secondary schools, a decision to provide religious instruction should be decided by the schools' boards of trustees and, if they allow teaching this subject, then students must be able to practice the religion that they wish (Human Rights Commission, 2009).

Thus, the Ministry of Education in New Zealand manages an education system based on an education strategy. This is called the National Education Guidelines (NEGs), which include the five following elements.

1- National Education Goals which are:

- i. Statements of desirable achievements by the school system, or by an element of the school system; and
- ii. Statements of government policy objectives for the school system.

2- Foundation Curriculum Policy Statements, which are statements of policy concerning teaching, learning, and assessment that are made for the purposes of underpinning and giving direction to

- i. The way in which curriculum and assessment responsibilities are to be managed in schools;
- ii. National curriculum statements and locally developed curriculum.

- iii. National Curriculum Statements; that is, statements of:
 - iv. The areas of knowledge and understanding to be covered by students;
 - v. The skills to be developed by students; and
 - vi. Desirable levels of knowledge, understanding, and skill, to be achieved by students.
- 4- National Standards are standards in regard to matters such as literacy and numeracy and are applicable to all students of a particular age or in a particular year of schooling.
- 5- National Administration Guidelines (NAGs) are guidelines relating to school administration (Ministry of Education, 2008, p. n.p).

2.3.3 The New Zealand national curriculum

The Ministry continuously reviews its national curriculum to ensure that students have the best educational opportunities. The New Zealand Curriculum 2007 (Ministry of Education, 2007a) is the most recent document issued by the Ministry. This guide is a clear statement of what the Ministry considers important in education. Its vision is to help students be “lifelong learners who are confident and creative, connected, and actively involved” (Ministry of Education, 2007a, p. 7).

This document also includes four dimensions that help achieve effective learning: Principles, values, key competencies, and learning areas. The first dimension is about what is important and needed in school curricula. The second one is about beliefs that are articulated by how students think and act. The third is about required skills for students to learn and take action: Thinking, using language (symbols, texts), managing self, relating to others, and participating and contributing. The fourth dimension is about learning areas. The New Zealand Curriculum 2007 defines eight learning areas: English, art, health and physical education, languages, mathematics and statistics, science, social science, and technology (Ministry of Education, 2007a, pp. 7 & 17). Moreover, there are eight levels in the curriculum that represent learning progress for each student across the learning years from Year 1 to 13 (Ministry of Education, 2007a, p. 45). Each level has several objectives. These objectives differ, depending on the philosophy and teaching goals of each subject. For example, technology has eight levels, each with several objectives that reflect the philosophy of this subject in the New Zealand context (Ministry of Education, 2007a). They include the three levels and the achievement objectives in primary schools (Ministry

of Education, 2007a). In the literature review section, I discuss technology education in the primary-education sector of the New Zealand curriculum. Technology has been taught either separately or integrated with other subjects, particularly with science. Therefore, there is a range of international models for teaching technology education. Some countries integrate science and technology, such as in Taiwan and Japan. However, I was not able to conduct my study in those countries because they do not teach in a language that I understand. In addition, I was granted a scholarship from the Saudi government to study in New Zealand to explore education. New Zealand recently signed an agreement with the Saudi government in terms of educational exchange. This paper will help Saudi Arabia explore educational experiences in new contexts, rather than old ones (such as the US) that have been working for a long time with Saudi Arabia to develop education. In addition, I took some technology education courses at Auckland University in 2007 and at Auckland University of Technology in 2009. These courses improved my knowledge about key issues in science and technology education, specifically in New Zealand, and gave me the required knowledge to investigate technology education in New Zealand.

2.4 Cultural and Educational Differences between the Two Contexts

Every country has its own culture that affects many different aspects of life, such as family, education and social behaviour. New Zealand and Saudi Arabia have significant differences in terms of culture and are influenced by many factors. In Saudi Arabia, all government policy and practice including education is driven by religious beliefs and customs. In New Zealand this is not the case, so it can be concluded that religion is a significant factor in the differences between education in New Zealand and Saudi Arabia.

In Saudi Arabia, Islam is the dominant religion that shapes the entire culture of the nation. According to the Oxford Dictionary (2015): “Founded in the Arabian Peninsula in the 7th Century A.D., Islam is now the professed faith of more than a billion people worldwide, particularly in North Africa, the Middle East and parts of Asia. The ritual observances and moral code of Islam were said to have been given to Muhammad as a series of revelations, which were codified in the Koran, 'the Holy Book'. Islam is regarded by its adherents as the last of the revealed religions, and Muhammad is seen as the last of the prophets, building on and perfecting the examples and teachings of Abraham, Moses, and Jesus.” Arabic is the language of the Koran and is also the official language of Saudi Arabia.

Thus, Islamic studies and the Arabic language are very important in the national curriculum. Saudi students must learn about Islamic studies and Arabic language with other topics such as science, maths, and English language (see Table 2.1). Education is taught in Arabic from the early stages. However, English is used in higher education as a key language to teach majors such as medicine and engineering.

Primary education in Saudi Arabia is theory-based learning that focuses on theoretical aspects and, although it is broad, the curriculum is very rigid. Traditional teaching methods are predominant and students are rarely given the opportunity to learn practically. The traditional (or conventional) teaching methods "are teacher-centered and include the use of lectures and discussions while the problem-solving element is presented by and/or discussed with the instructor; the syllabus, the teaching materials and the student assessments are determined by the tutor and transmitted to students in various lectures" (Dimitrios, Labros, Nikolaos, Maria & Athanasios; 2013, p.76).

Education in Saudi Arabia is segregated, meaning boys and girls have separate schools. This is a result of the Saudi culture that holds that girls and boys have different attitudes to learning. Thus, providing each gender with a suitable environment will enhance their academic performance. This does not mean that they have a different curriculum, they have almost the same curriculum but home economics is a subject that is taught only at girls' schools.

Female and male teachers also have different training institutes, either before or in-service, and they have same duration of training. They study four years full time in teachers' colleges or universities; usually the teachers' colleges are not connected with the universities. In terms of in-service training, there are a range of short and long training courses that the Ministry of Education offers for teachers in order to keep them updated with new educational topics.

In contrast, the New Zealand state education system is secular with religious studies falling outside the curriculum. However, a few state-integrated and private schools offer religious education. Students in New Zealand can learn a range of topics but the curriculum does not support interpreting these topics through any religious perspective. New Zealand has three official languages: English, Māori and New Zealand Sign Language. English is the

primary medium of teaching. In addition, education in New Zealand gives considerable attention to the Māori language in order to support the Māori culture by providing all Māori learners the opportunity they need to realise their unique potential and to succeed as Māori and also to support community and iwi commitments to Māori language intergenerational transmission and language survival (Ministry of Education, 2015). Education systems encourage students to be involved more in practice than in theory.

By comparing Saudi Arabia to New Zealand it can be understood that there are significant differences between them in terms of education and culture. For example, in Saudi Arabia, Islam, as an official religion in this country, plays a major role in shaping both education and culture of Saudi community while in New Zealand there are a range of religious practices but have no affect on education and do not support interpreting teaching and learning through any religious perspective. In Saudi Arabia, the Arabic language is the official language while English is used in higher education as a key language to teach majors such as medicine and engineering. New Zealand has three official languages: English, Māori and New Zealand Sign Language. Primary education in Saudi Arabia is theory-based learning that focuses on theoretical aspects and there is less focus on practical learning that is given more attention in the New Zealand education system that encourages students to be more involved in practice than theory.

2.5 Summary

This chapter has provided the reader with historical and educational information of both contexts. The next chapter will focus on theoretical framework.

Chapter 3

Theoretical and Conceptual Framework

3.0 Introduction

This chapter traces and discusses the relevant literature in the area of technology education, both internationally and nationally (Saudi Arabia). The chapter is divided into two main sections: the first discusses the theory underpinning the study, while the second discusses relevant literature that answers the study's research questions based on four themes. These themes are: (1) the relationship between science and technology; (2) technology education in international and national official documents; (3) teachers' perceptions of technology education, and (4) implementing technology education in classroom.

3.1 Section 1: Underpinning Theory

This section outlines critical education theory (CET) as a theoretical framework for this study. The general aim of using this theory is to contextualise the study through the most appropriate theoretical framework. This study aims to describe the current state of technology education in New Zealand and Saudi Arabia by explaining how it was documented and implemented in both contexts. In other words, CET describes the issue and suggests solutions, rather than critiquing data that might not answer the research questions.

This section will explain CET and its elements, and why it is different from other theoretical frameworks.

3.1.1 Contextualising the study critically

Since the turn of the century, communities around the world have undergone a process of unprecedented technological revolution. This revolution has pushed many countries to develop and reform their education systems by exchanging experiences and information with other countries and conducting educational research and comparative studies in the hope of establishing a better society (Pavlova, 2005). As an academic researcher and technology teacher in Saudi Arabia, I intend to comparatively explore modern ideas that will help inform and reform technology education in Saudi Arabia.

Education reform is seen globally as a crucial step in preparing students for the changes that have occurred as a result of this technological revolution. As an educator who is aware of the Saudi education system and has a background in science and technology, I believe that the Saudi curriculum and delivery of technology education must be critically re-examined and reconstructed. Such action will help the Saudi Arabian community to meet the challenges that Kellner (2003, p. 51) articulated with regard to “developing new literacies as a response to new technologies and a new critical pedagogy to meet the challenges of globalisation and multiculturalism.”

It is in the context of these broader challenges that I have chosen to view my research through the lens of Critical Education Theory, or CET. CET addresses the composition of what is taught and the way in which is taught in the context of social, political, cultural, economic and environmental circumstances (Ward, 2013). According to Ward (2013, p. 4):

“Critical Education Theory evolves from the wider discipline of Critical (Social) Theory, and looks at the ways in which political ideology shapes education as a way of maintaining existing regimes of privilege and social control. It casts a critical eye upon the history, the development and practice of education and educational theorising ... critical education theory promotes an ideology of education as an instrument of social transformation and as a means of attaining social, cultural, and economic equity. Initially, it did this from an orthodox (economic) Marxist point of view, but increasingly has adopted many of the tenets and theories of Cultural Studies to demonstrate how cultural codes play a fundamental part in both curriculum construction and classroom practice. The field covers a wide range of educational issues – the curriculum, the pedagogy or teaching style, the role of the State, the influence of corporate power, the so-called hidden curriculum, issues of cultural and individual identity etc.”

CET is an offshoot of critical theory, which first emerged in Germany with the establishment of the Institute for Social Research at Frankfurt in 1923 (Peters, Lankshear, & Olssen, 2003). Theorists at the Frankfurt School (Darder, Baltodano, & Torres, 2009, p. 27) came together from a wide range of disciplinary backgrounds to alleviate suffering and poverty following World War I and bring about a more equal and just society. In 1937, Horkheimer coined the term *critical theory* to describe the school’s theoretical program (Peters et al., 2003, p. 3). The theory denotes a substantial body of thought and work that

provides a fundamental resource for educational theorists who wish to engage in ongoing investigations of the relationships between power and knowledge, and education and its social context (Darder et al., 2009). The practice of CET in the classroom context is called *critical pedagogy* (Peters et al., 2003).

Giroux (2011) is one of founding theorists of critical pedagogy and one of the influential thinkers in education, claiming that ‘educators and other educational workers need a new political and pedagogical language for addressing the changing contexts and issues facing a world in which capital draws upon an unprecedented convergence of resources – financial, cultural, political, economic, scientific, military, and technological – to exercise powerful and divers forms of hegemony.’ (p. 69)

Peters et al. also claimed that teachers have a responsibility to become “transformative intellectuals” in schools and society; that is, to develop the formal educational process in the direction of greater equity and justice, and promote the emergence of a participatory democracy (Giroux, 1988). According to Giroux’s critical pedagogy: “When evaluating the schooling process, it is wrong to disconnect the school curriculum and its other texts from its cultural and social contexts” (Peters et al. 2003, p.20). This precisely explains the theoretical basis for this study.

CET has elements that make it a suitable framework for any work that aims to investigate issues related to reforming education (Young, 2000). CET addresses educational issues from a multi-disciplinary perspective. It investigates education (policy, curriculum, and pedagogy) and shows how it is influenced by existing regimes, ideologies (culture), and power structures. It also helps us understand the future of education in relation to a vision of the future of society.

I found this theory different from other theoretical frameworks because it not only describes how the current educational system looks, but also explains how the educational system works and why there should be changes. It also covers many educational issues, including curriculum, pedagogy or teaching style, the role of the state, the influence of corporate power, other issues of cultural and individual identity, and how people interact with these issues based on their social, cultural, and political backgrounds. Other frameworks, such as social constructivism, behaviorism and

cognitive constructivism, are mainly used to understand human learning in relation to environmental stimuli. These theories can be beneficial for understanding students' learning in the classroom, in order to improve teaching methods (Schunk, 2008). These theories can be used to discuss internal issues in educational institutions, while CET addresses internal and external educational issues that help reform education.

This study is set in the Kingdom of Saudi Arabia, which has a complex culture and lifestyle. People in power are represented in this study by the Ministry of Education which controls every aspect of the educational process. Students (particularly females) are not given the choice to examine how society shapes and constrains their aspirations and goals. In this study, CET describes how the current educational system looks and explains how it works in particular ways, and why there should be changes.

By taking into account an analysis of curriculum and pedagogy based on cultural and social contexts, this study aims to investigate technology education in New Zealand and Saudi Arabia in order to explore how it is implemented in each context, but also to inform the Saudi context based on New Zealand's long experience of teaching technology education. Given this intention to import alternative models of technology education into the Saudi educational context, with all of the cultural implications that this may involve, CET provides an appropriate theoretical framework through which to proceed. The reciprocal but problematic relationship between knowledge, teaching practice and cultural identity has been long understood (Darder, 1991, pp. 25–28) and is a significant component of any cross-cultural exchanges in which the dangers of violating cultural norms are present.

3.2 Islamic Education

Islamic science has a long and rich history. Islamic scientists were studying subjects such as astronomy, geometry, geology, mineralogy, agriculture, trigonometry, geometry, physics, chemistry, pharmacology, botany and zoology centuries before the West. Indeed, Western universities were modelled closely on the examples of the Islamic *madrasah* (literally “place of lessons”). Education traditionally revolved around two basic dimensions of the Islamic philosophy of knowledge: unity and a hierarchy of classified knowledge systems. These systems were made up of a hierarchy derived from the intellectual/personal to the revelatory/divine. All of these systems denoted a natural divine

unified order, since the philosophy even viewed personal/intellectual capability as a God-given faculty (Nasr, 1976; 2007, p. 131). The two forms of knowledge that have been traditionally accepted as an epistemological framework are:

- Transmitted sciences – revealed by God and passed down from generation to generation (*al-‘ulüm al-naqliyyah*); and
- Intellectual sciences – knowledge acquired through human intelligence and reason (*al-‘ulüm al-aqliyyah*).

These, together with the notion of “visionary” knowledge of wisdom or gnosis (*al-‘ilm al-hudiri*) or knowledge by presence, have guided traditional Islamic education practices for centuries (Nasr, 1976).

Thus, the classifications of scientific knowledge were developed to include a *spiritual* dimension that is at odds with the nature of Western notions of knowledge that treat science as an *agnostic* phenomenon – that is, excluding any reference to the *spiritual*. Between the 13th and 19th Centuries, the introduction of Western knowledge systems was very damaging to Islamic scientific knowledge systems, and even now the contradictions and tensions between these two ideologies continue to exert an influence in Saudi education (Tibawi, 1972). Any introduction of Western technology education systems into the Saudi context must address these dilemmas.

In Western education, the primary goal is the development of the intellect. In Islamic education, on the other hand:

“Being related to holiness hence wholeness ... had to be concerned with the whole being of the men and women that it sought to educate through the process of imparting knowledge combined with integration of the mind and soul of the student. Its goal was not only the training of the mind, but that of the whole being of the person ... It never divorced training of the mind from that of the soul and in fact the whole being of the student. It never considered the transmission of knowledge to be legitimate without the possession of appropriate moral and spiritual qualities. In fact the possession of knowledge without these qualities was considered dangerous.” (Nasr, 2007, p. 131)

This basic difference between the Western and Islamic Education regarding the role of the moral and the spirituality has profound implications, not just in terms of cultural assimilation and/or colonisation. It also goes to the heart of many current global crises. By excluding the spiritual, Western science (which developed alongside and in complicit relationship with capitalism and colonisation) embodies an ideology that views human existence as over and above the existence of all other life forms and as *exterior* to nature. In Western science, there is an underlying assumption that we as humans stand apart from and (based upon Christian notions of God-given rights of domination) are free to commodify and exploit the “resources” of the planet to our own benefit. The Earth, in this paradigm, is simply seen as an inexhaustible resource for human exploitation.

Islamic Education also employs the notion of human exploitation of the resources of the planet alongside other Islamic notions that are derived from the Qur'an, including the following:

- 1- “And cause not corruption upon the earth after its reformation. And invoke Him in fear and aspiration. Indeed, the mercy of Allah is near to the doers of good.” (Chapter 7, Verse 56)
- 2- “And O, my people, give full measure and weight in justice and do not deprive the people of their due and do not commit abuse on the earth, spreading corruption.” (Chapter 11, Verse 85).
- 3- “And when he goes away [Man], he strives throughout the land to cause corruption therein and destroy crops and animals. And Allah does not like corruption.” (Chapter 2, Verse 205)
- 4- “And remember when He made you successors after the 'Aad and settled you in the land, [and] you take for yourselves palaces from its plains and carve from the mountains, homes. Then remember the favours of Allah and do not commit abuse on the earth, spreading corruption.” (Chapter 7, Verse 74)

The Qur'an is considered the main reference in education in the Islamic countries. The Qur'anic discourses address two dimensions, one related to faith issues in detail and the

second related to life issues as social, politics, economy, education and others (Rayan, 2012). This ideology has shaped the educational policy in Saudi Arabia, which emphasises the use of education as a channel to connect people to their Lord and to exploit the resources of the earth in a way that brings benefits to humanity. The first section of the Saudi Education Policy includes 27 articles that state the general principles of education that are derived from Islam, requiring that this religious dimension be taken into account in any attempt to develop science and technology in the Saudi curricula. Education in Saudi Arabia welcomes any scientific and technological advancement *that helps humanity*, but it analyses it through the lens of Islamic teaching to ensure that it does not contradict the educational policy that has been prepared to create a generation that can benefit from all types of knowledge, including science and technology, to achieve a purpose that is useful for the national and the international community.

However, as we shall see later, the precept that the Qur'an offers about the exploitation of the world's resources *for the benefit of all humanity* may have to be reinterpreted in light of the global environmental crisis. It may no longer be "in the interests of humanity" to exploit and burn any more oil and gas. Indeed, it may be that the exploitation of the natural oil and gas resources of the Saudi people may be the critical factor that brings about the end of humanity itself.

3.3 The Social Construction of Western Education: A Brief History

There are reasons other than the dangers of cultural insensitivity for taking a critical approach. The technological and digital revolution that is transforming the world is not the only revolution that educational systems must face. Other present and impending crises – economic, social and environmental – pose equally unprecedented challenges that will have a profound impact on the future development of technology education, both in Saudi Arabia and worldwide, and these too support the choice of a multi-faceted critical approach. One of these revolutions is in the field of education itself, where the emphasis of policies has changed significantly over the last 20 years (Ghazanfar, 2005).

Education has always operated as an instrument of social distinction, separating the cognoscenti from the masses (Ward, 1997). It played a critical role in the pacification and assimilation of indigenous peoples (Etienne & Leacock, 1980, pp. 27–288).

Critical Education theorist Young (1987, p.167) acknowledges this pacifying role in education in society, but suggests that it has changed over time. The purpose of education has been viewed differently at different times. Young roughly divides the perceived social role of education into three phases:

- 1- From the early 1900s to 1945 – as a means of social pacification (as noted above)
- 2- From 1945 to 1974 – as a means of national economic productivity
- 3- From 1974 to the present – as a national economic burden.

After the Second World War, American economic, industrial and military ascendancy precipitated a shift of emphasis towards production and imperial growth, monopolising global resources and markets. These were the halcyon years of Western education, in which schooling was free and jobs were plentiful. It was during this time that Critical Theorists began to cast their attention to the relationship between industrial and economic power and education. Bowles and Gintis (1976) were among the first to question the neutrality of the education system. Their so-called Correspondence Theory suggested that education was organised and shaped not as a vehicle for personal emancipation, but to produce workers with skills corresponding to the numbers and needs of industry.

This view accords closely with the theories put forward by Karabel and Halsey (1977) of education as a kind of investment in cultural or human capital. According to this theory, the educational investment would return an economic profit to an individual over a lifetime of employment. By the same token, the cumulative economic profit accorded to individuals would, by extension, flow into the competitiveness of the national economy, increasing investment and exports and leading to general prosperity. During this era, this philosophy developed alongside, and to a large extent influenced, a general expansion of the educational system and a massive investment in the educational budgets of most Western States. The expansion of the education system was also associated with the return of thousands of veteran servicemen from the war who demanded better opportunities for their children than they themselves had experienced.

3.4 An Emerging Crisis in Education

According to Young (1965), by the mid-1970s the economic burden of these educational costs had started to outweigh their perceived economic usefulness to the system. The tax burden that they imposed upon capital, with its consequent reduction in profits, required that economies be made. Education (particularly university education) became seen as an economic burden rather than an economic investment. This view was particularly prevalent since research had not been able to point to any actual economic benefits at the national level from increased educational provision (Berg, 1983). Instead, increased levels of educational achievement had simply increased the qualification demands of prospective employers, creating what has been called “credential inflation” (Collins, 1977).

Credential inflation meant that paper qualifications carried less and less cultural and symbolic value. Many highly qualified people had to accept low-prestige jobs and the cost of user-pays education left many with un-payable student loan debts, meaning that the rewards of education are often not commensurate with the costs. This has increasingly meant that only the wealthy can afford to be educated, which is creating a two-tier graduate system and accelerating the shift towards enormous social inequalities that have not been seen since the Great Depression of the 1930s (Saez & Zucman, 2014) and are both socially and politically unstable and unsustainable (Dorling, 2014). The shift towards a market-driven education policy has been accompanied by a parallel move towards privatisation, with the introduction of charter schools, which has increased educational and therefore social disparities (Frankenberg & Lee, 2003).

3.5 The Economic Crisis

Prior to 1974, in the “Golden Age” of education, the average graduate could rely on the availability of job choice: there were more jobs available than there were graduates to fill them. This is no longer the case. In the United States, for instance, the supposed “recovery” from the 2007 Recession has been primarily on the stock market, fuelled by quantitative easing (the availability of low-interest money printed by the Reserve Banks) (Fieldhouse, 2014). The modest increases in available jobs have been primarily in the low-income service areas. This lack of available jobs has exacerbated both the trend towards credential inflation and increased profits, since the increases supply of labour (itself a function of the means of production) has become cheaper. According to Reich (2014) (Bill

Clinton's secretary of labour), the 2014 indicators in the United States (still the most influential economy globally) showed that:

- US retail sales were flat
- Median real wages were flat
- Almost half the revenues of large American companies came from foreign sales but markets abroad were stagnant, and
- The ratio of stock prices to company earnings was higher than it had been since before the 2008 stock market crash.

The only reason stock prices continued to advance is because they were being sustained temporarily by the following factors:

- Corporate stock buy-backs and mergers
- Anticipated tax reductions through "inversions" (companies planning to leave the US)
- Low bond yields that continue to drive pension funds and other institutions into stocks, and
- Capital flows from the rest of the world, for which the American stock market is a safe haven compared to the uncertainty in other countries. (Reich, 2014)

This situation continues unabated, along with the fact that the cost of living in the US dropped in August 2014 for the first time in more than a year. Because of very low domestic consumption (because wages do not stimulate consumer power) and declining global markets (Europe is close to recession and China is precarious), the prices of many goods and services are dropping, causing deflation. Instead of this situation stimulating demand, the recovery from the recession seems to be faltering (Inman, 2013; Pankhurst, 2013).

According to a recent report issued by the Organisation for Economic Co-operation and Development (OECD), climate change is a major factor in the current economic recession. The report suggests that the current recession will never end for an increasing number of people (Braconier, Nicoletti and Westmore, 2014). The report indicates that growth will slow to approximately two-thirds of its current rate, that inequality will increase greatly,

and that there is a significant risk that climate change will make things worse. However, the OECD predicts that even before these things occur, economic increases in the developing world will cease, while economies in the developed world (including New Zealand) will stagnate. Consequently, the growth of high-skilled jobs and the automation of medium-skilled jobs mean that inequality will increase by 30 percent.

In New Zealand, the Department of Labour (2008) indicates that environmental pressures, especially climate change and natural resource constraints, will also influence change in the job market: “In the years up to 2020 and beyond. New Zealand’s long-term economic viability is closely tied to its natural environment and the availability of resources, including energy. The transition to a sustainable, low-carbon economy will involve major shifts in employment, skill sets and workplace practices – all of which need to be better understood if New Zealand is to take advantage of a variety of new opportunities” (p. 16). Also, it indicated that future success will involve supporting sectors and skills to foster leadership and capitalise on arising opportunities

3.6 Education and Debt

It has often been suggested that education and retraining is one way that people can diversify their skills and improve their chances of finding a job. It is not only unskilled people who are suffering. The economic problem is exacerbated by the mass-migration of skilled graduates who (through their debt-inducing education) are forced to look elsewhere for work in a diminishing market. In 2013, *The Guardian* reported that, throughout Europe, more than 5.5 million under-25-year-olds were unemployed – these are the so-called the “lost generation” (Henley, 2013). If we include those young people who are in education in an attempt to increase their employability, the so-called “economically inactive” now include millions of young people who are not in work, education or training but who, while technically not unemployed, are nonetheless jobless – and have all but given up looking, at least in their own country (Henley, 2013). As one economist put it: “If born in 2014, then by 2060 you are either a 45-year-old barrister or a 45-year-old barista” (Mason, 2014).

A recent study by the University of Thessaloniki found that more than 120,000 professionals, including doctors, engineers and scientists, have left Greece since the start of the crisis in 2010. Such a dramatic loss of human and intellectual capital makes it

increasingly unlikely that countries like Greece will retain the skills and knowledge needed to recover from the present economic crisis (Lowen, 2013). The result of this economic assault has been a hollowing-out of the middle class that have traditionally borne the burden of state taxes and supported continuing consumption. This has resulted in an ever-escalating gap between the very rich and the growing ranks of the poor, leading to increased social unrest and state repression. Such events are but a harbinger of things to come. Warnings have come not just from fringe players, but from organisations like the World Economic Forum, which noted that the chronic gap between rich and poor is yawning wider, posing the biggest single risk to the world (World Economic Forum, 2014).

This failure of the global economy to recover from the 2007 collapse has led some economists to predict the current situation as “the new normal” (Wheatly, 2014); that is, as a permanent state that we must learn to accept and live with. Add to this the projected effects of climate change – loss of productive land and capacity, mass migration of populations with possible regional and global conflicts, increasing incidences of disease and infection, etc. – and the prospect of recovery becomes increasingly bleak.

3.7 The Elephant in the Room: Climate Change

The OECD report entitled *Policy Challenges for the Next 50 Years* notes that one of the major factors affecting potential global economic recovery will be climate change (Braconier et al., 2014). The issue of climate change has been debated; it is a fact, supported by a large number of scientists. Furthermore, it is not a future event, but is happening already, according to US Environmental Protection Agency (US EPA, 2014). The vast majority of scientific evidence suggests serious if not catastrophic future events, and it may already be too late to prevent these. Climate change is being affected by a series of identifiable and interrelated factors, such as carbon dioxide, the burning of fossil fuels and deforestation and desertification.

3.8 Burning Fossil Fuels

Eighty-seven percent of all human-produced carbon dioxide emissions come from the burning of fossil fuels such as coal, natural gas and oil. The remainder results from the clearing of forests and other land use changes (9 percent) and some industrial processes such as cement manufacturing (4 percent) (Le Quéré & Peters & Andres, 2013). In 2011,

fossil fuel use created 33.2 billion tonnes of carbon dioxide emissions worldwide (Cusick, 2013). The three most commonly used types of fossil fuels are coal, natural gas and oil. Coal is responsible for 43 percent of carbon dioxide emissions from fuel combustion, with 36 percent produced by oil and 20 percent from natural gas. Furthermore, global carbon emissions are increasing worldwide, and have increased 61 percent since 1990. This trend has occurred despite repeated and failed international attempts to cut back emissions since the 1992 UN Conference on the Environment and Development in Rio de Janeiro (Le Quéré et al., 2013).

3.9 Reducing Fossil Fuel Consumption

For a major oil-producing country like Saudi Arabia, the implications of this climate crisis are very serious. Apart from the direct impact of climate change itself (reduced availability of aquifer water, increased desertification, etc.) there remains a more serious and immediate economic concern. Saudi Arabia possesses approximately 16 percent of the world's proven petroleum reserves and ranks as the largest exporter of petroleum (US EIA 2014). The petroleum sector accounts for roughly 80 percent of budget revenues, 45 percent of GDP, and 90 percent of export earnings. The Saudi economy is so dependent on oil and gas revenues that any curtailment in production to reduce greenhouse gas emissions would very have a serious effect (Mundi Index, 2014).

3.10 The Impact on Education

According to Ward (2013), there are dangers to be found in transferring educational practices from one culture to another without carefully analysing the potential impact. Therefore, I framed this work through the lens of CET in order to understand what some of these potential effects might be. In this section, I provide an in-depth description of CET and some of the issues that it raises for this study. As Giroux (1988) noted, when evaluating the schooling process it is wrong to disconnect the school curriculum and its other texts from its cultural and social contexts.

In the context of this study of science and technology in education, it became clear that the issues involved were deep and wide-ranging – indeed, global. The predicted permanence of the present economic recession; the global climate change with all of its social, environmental and health implications; and the future economic reality for fossil fuel

production (particularly in the Saudi context) all impact on the future role of technology education in the Saudi education system. They do so directly, since it is clear from this research that Saudi Arabia needs to shape its technology education curriculum in order to meet the needs for future generations to be technologically literate in the fields of alternative technologies and in environmental sustainability. The findings also have an indirect implication.

The state of the world's climate is dire, and only the most rigorous changes in our global consumption and in the uses of sustainable energy will avert catastrophic social, economic, and environmental consequences. This means that there is a real need to immediately develop a wide and extensive public awareness of global environmental issues. This, of course, should be one of the primary aims of technology education. But being aware is not enough. The scale of the need to sustain the global environment suggests that every citizen must take an *active* role in the process of controlling the production of CO₂ and other greenhouse gasses, and in curtailing industrial practices that damage the ecosystem. This suggests that the purpose of education must move beyond the role of *informing* students with facts, and should instead adopt policies and teaching practices that help to produce graduates practised in *active citizenship* – that is, critical pedagogues who are able to spread and develop a movement for environmental sustainability.

In the Saudi Arabian context, and particularly in the context of technology education, it will be readily apparent from all of this that there is an immediate need to initiate changes to both the curriculum and the teaching practice. It is important that the Saudi people have the time and the opportunity to adjust to these impending changes. Specifically, it is important that the Saudi community as a whole develops the technological capacity to ride out and mitigate the worst effects on their climate and on their economy. This has several implications. It means, for instance, that both the visible curriculum – that is, the content of the “official” curriculum and the “hidden curriculum” – will need to be shaped to address these emerging needs of the Saudi people. These implications will be explored in Chapter 6.

3.11 Summary

CET was the launch point for designing research questions, selecting the relevant literature, and choosing realistic methodology for collecting and analysing data. This

chapter has provided a theoretical framework that offers the basis for a shaping of technology education in the Saudi context, and addresses the cultural differences between New Zealand and Saudi education systems, as well as the needs of the wider Saudi community in the face of impending social, economic and environmental changes. The next section focuses on reviewing the literature.

3.12 Section 2: Literature Review

The international literature on technology education is extensive and covers theoretical and practical aspects of technology education, but there has been a noticeable lack of it in certain national contexts (such as in Arab countries, including Saudi Arabia). The literature shows that several countries have included technology education in their national curricula and each country has its own approach to develop and implement the subject in schools. I have chosen to look at five countries – the United States, the United Kingdom, Finland, Australia (New South Wales State) and New Zealand – with regard to their experiences in terms of this subject. In fact, I chose them for two reasons based on my point of view: their long history in teaching the subject, and the fact that they are ranked highly in global education. I chose Saudi Arabia as the country to be examined in terms of its literature, as it is my home country.

This section sheds light on the following aspects: (1) the relationship between science and technology; (2) technology education in international and national curricula; (3) teachers' perceptions of technology education; and (4) the implementation of technology education in classrooms.

3.12.1 The relationship between science and technology

Science and technology have been included in international curricula as major subjects that combine with other subjects to provide students with essential theoretical and practical skills (Jones, 2009). For many years, scientists, technologists, science teachers, technology teachers, politicians and members of the community in general have not been able to reach a general agreement on a framework that determines the relationship between science and technology. A suitable framework might be used as a guide for science and technology teachers to teach both subjects, either independently or interdependently. In the case of France, Lebeaume (2011) stated, "Technology education has a long history in the

dynamics of design and implementation of compulsory school subjects: there have been numerous tensions about its specific contents and its relationship with scientific school disciplines, especially with physics-chemistry” (p. 77).

Similarly, in the UK, despite school politics emphasising the difference between science and technology without considering the similarities between them, the Thatcher Government encouraged and financially supported the initiative of a Technical and Vocational Education Initiative to integrate science and technology as a combined curriculum (McCormick & Banks, 2006).

Albe and Bouras (2008) considered technology to be an application of or subservient to science. Also, attempts to integrate technology with science have emphasised technology as an applied science and have presented a very limited view of technology that has restricted the learning in both subjects (Jones, 2007), although their relationship within education can be beneficially explored to enhance learning in both areas (Compton, 2004a).

The issue of considering technology as applied science has created a great deal of debate with regard to the relationship between science and technology in the curricula (Kipperman, 2006). According to Gravemeijer and Baartman (2011), this debate is caused by the absence of a clear agreement among scientists and technologists on the definitions of science or technology or the relationship between science and technology. Thus, it has been quite common for people “to talk about ‘science and technology’ as if it were one thing with a double-barrelled name” (Sparkes, 1993, p. 25). Cajas and Gallagher (2011) referred to a cluster of articles published in the *Journal of Research in Science Teaching* (2001, 38(7)) that analysed the relationship between science and technology. The summary that emerges from these articles is that there is a complex relationship between science and technology and “such complexity should be reflected in the school curriculum” (Cajas and Gallagher, 2011, p.713). Cajas and Gallagher (2011) called for a re-evaluation and re-study of this relationship. De Vries (2001) explained that the study of the complex relationship between science and technology can be pursued by tracking the history of industrial research laboratories and provides a good opportunity for understanding why and where such complexity exists. I believe that it is essential to reveal these points of view about this issue, to examine them in order to determine the relationship between

science and technology, and to deliver this message to everyone who is interested in this field – especially science and technology teachers – in order to improve their understanding of this contentious issue.

Many articles have been written about the relationship between science and technology, but the literature indicates that no framework has been developed that clearly articulates this relationship (Compton, 2004a; Gravemeijer & Baartman, 2011; Jones, 2007). “Attempts to distinguish between the two based on epistemological criteria have been less than convincing” (Custer, 1995, p. 226).

The main point of my thesis is to present an image of the relationship between science and technology and to have a robust understanding of this relationship in the curriculum. I hope that this will assist to develop a pedagogical model that represents the relationship between science and technology. This thesis discusses this relationship by shedding light on four main points: (1) the nature of science; (2) the nature of technology; (3) the nature of the relationship between science and technology; and (4) a pedagogical model of the relationship between science and technology in the curriculum.

3.12.2 Nature of science

The nature of science is a generic concept comprised of various components or sub-concepts that help people understand what science is. Hodson (2012) identified three major areas of scientific literacy: learning science, learning about science, and doing science. He declared that the second component, learning about science, includes the following factors that represent the nature of science: language, theoretical views, norms and traditions of science. McComas and Almazroa (1998) provided a comprehensive explanation of the nature of science that was directed at science teachers to help their students understand this concept. They explained that it is about mixed aspects of diverse social studies of science: “The history, sociology and philosophy of science with research from the cognitive science into a rich and useful description of what science is and how it functions” (p. 511). Based on Hodson’s suggestion and McComas and Almazroa’s (1998) explanation of the nature of science, we propose that these aspects shape the knowledge that educators and their students should first hold in order to learn about science.

Understanding the nature of and grounds for knowledge itself (epistemic cognition) is a prerequisite for any understanding of the nature of science (and, likewise, technology) (France & Gilbert, 2005). Moshman (1998) defined epistemic cognition as “an aspect of metacognitive understanding involving knowledge about the nature and limits of knowledge, including knowledge about the justifiability of various cognitive process and actions” (p. 964). Based on this definition, we can increase our understanding of the nature of either science or technology that can be determined through knowledge about their processes and actions. He indicated that a variety of theories and research programmes have focused on the development of epistemic cognition. Children, adolescents and adults were involved in the research to understand the stages of the development of ideas about the nature of knowledge across these ages. He concluded that there are three development stages: objectivist, subjectivist, and rationalist.

The objectivist stage “construes knowledge as absolute and unproblematic. Justification, if considered at all, is simply a matter of appealing to direct observation or to the pronouncements of an authority” (Moshman, 1998, p. 694). At this stage, people accept and have an absolute belief in the scientific knowledge that is pronounced by scientists. This scientific knowledge includes laws and theories used to explain and describe everyday events, problems and phenomena (Naughton, 1993). In general, scientific knowledge is a systematic and methodological method that scientists use to discover reality and is the key concept that represents the nature of science. Two terms that are frequently used to discuss the nature of science are “scientific knowledge” and “science”. There is no difference between the two terms and they reflect the concept of “science”.

The subjectivist stage is where “Knowledge is deemed to be uncertain, ambiguous, idiosyncratic, contextual, and/or subjective; justification in any strong or general sense is considered impossible” (Moshman, 1998, p. 694). France and Gilbert (2005) attributed this to a lack of understanding scientific knowledge that leads people to reject scientific arguments and all other consequences resulting from it.

The rationalist stage is where people recognise that “There are justifiable norms of inquiry such that, in some cases, some beliefs reasonably may be deemed to be better justified than others” (p. 295). In this stage, people have the scientific norms that help them accept the scientific facts as truthful or have some they might have some errors.

France and Gilbert (2005) found that the nearest approach to an analysis of the epistemic status of the nature of science in public was the review of Koulaidis and Ogborn (1995), which reviewed science teachers' views on the conduct of scientific enquiries and the status of the outcomes. Koulaidis and Ogborn identified four fundamental views: inductivism, hypothetical deductivism, contextualism, and relativism.

Inductivism enables people to consider science as a process in order to collect the final scientific facts derived from regular observations of general laws.

Hypothetical deductivism: People can propose hypotheses about a particular phenomenon, and expose these hypotheses to experimental research to approve correct ones and to eliminate others.

Contextualism: Specific scientific theories are judged in terms of the notions of successful scientific enquiry prevailing at that time.

Relativism: There are no specific characteristics of scientific knowledge that can be used as a standard against which to compare other forms of knowledge. This point of view is supported by Pitt (2001), who indicated that there has been no general agreement as to the criteria for scientific knowledge.

Compton (2004a) identified three key criteria that can be used to differentiate between science and technology: the purpose of science, the ontological stance and the epistemological aspect. These criteria can be used logically to discuss the nature of science and the nature of technology if the first criterion is changed to the purpose of technology and the second is thought of in relation to technology rather than science. These criteria are key factors in theory and practice of science and technology and are fundamental to discussing the relationship between the two disciplines.

First, Compton suggested that the purpose of science is to *explain* natural events through reiterated observations and control. Similarly, Pitt (2001) stated that the ultimate aim of scientific enquiry is explanation in order to understand the way the world occurs to us.

Secondly, Compton (2004a) also suggested that the ontological stance of science plays a prominent role in helping us to understand the nature of science. This stance reflects a contemporary view of those who consider science as a “critical realism” and claims that things are still the same as they were since ancient history. Scientists adhere to the so-called ‘correspondence theory of truth’ to discover reality of any matter that people want to know about (Lepoze & Potter, 2001). The ontological stance attempts to inquire into the form and nature of reality and what can be known about it including “how objects really are” and “how do they really work?” (Guba & Lincoln, 1994, p. 29). The role of scientists, in this case, is to scientifically enquire about reality to generate a clear explanation of it. The explanation is followed by regular observations to introduce reliable facts.

Finally, the epistemological aspect is the third criterion used to differentiate between science and technology. This aspect represents the nature of the relationship between people and reality (Guba & Lincoln, 1994). Guba and Lincoln asserted that a person who works to discover the reality must be value-free in order to reach accurate and realistic results (knowledge) of his or her research. Developing knowledge is a substantial aim of science (De Vries, 2012); this knowledge “must adhere to logical reasoning and be internally coherent within the dominant paradigm ... It must withstand peer review in order to be represented as ‘truth’” (Compton, 2004a, p. 2). The epistemological aspect of science is how knowledge is scientifically acquired and how it is transmitted to recipients. Scientific knowledge in science attempts to make claims to a ‘truth’ that represents the epistemological basis of science (France & Compton, 2006).

As educators, we must aim to help students to not only gain knowledge of how things in the natural world act (*ideas of science*) but also how this knowledge is structured and developed (*ideas about science*) (Harlen & Léna, 2011, p. 2).

In summary, the nature of science and technology is a generic concept that can be understood from different points of view. For example Moshman (1998) suggested that there are three development stages of understanding the nature of science and technology: objectivist, subjectivist, and rationalist. Other philosophers such as Koulaidis and Ogborn (1995) suggested that inductivism, hypothetical deductivism, contextualism, and relativism are key views to better understand the nature of science and technology. Compton (2004a) identified three key criteria that can be used to differentiate between science and

technology: the purpose of science, the ontological stance and the epistemological aspect. All these points of view could lead to the development of knowledge that is a substantial aim of science and technology (De Vries, 2012), and we need to help students to understand how this knowledge is structured and developed, according to Harlen & Léna (2011).

3.12.3 Nature of technology

In order to understand the nature of technology, we must – as in the case of the nature of science – understand the purpose, the ontological stance, and the epistemological stance of technology.

The purpose of technology can be understood through the definitions of technology given by some science and technology experts. Naughton (1993) defined technology as “the application of scientific and other knowledge to practical tasks by organisations that involve people and machines” (p. 9). He said that a general purpose of this definition is to solve the problem or to make something. This definition is generally too narrow because it considers technology as applied science and it neglected technology as a form of human activity that involves a range of dimensions as identified by McGinn (2010) who explained that technology is a form of activity that is fabricative, material product-making or object-transforming, purposive, knowledge based, resource-employing, methodical, embedded in a sociocultural environmental influence field, and informed by its practitioners’ mental sets. McGinn’s point of view was also supported by France and Compton (2006) who referred to technology “as a form of human activity that exists through the purposeful intervention of technology; the intervention is specifically designed to meet needs or realise opportunities as they are perceived to be within specific time, space and place locations” (p. 4). Thus, France and Compton (2006) believed that technology as a human activity allowed the production of innovative solutions and provided the means to extend human capability to create useful things required to solve life’s problems. This suggested purpose of technology was also identified by Atkin (1998) when he explained that the purpose of technology was to create something that people wanted or that made their lives more productive.

The second factor that helps us understand the nature of technology is the ontological stance of technology. Phenomenology is a philosophical stream that constructs a view of

technology. De Vries and Dakers (2009) suggested that the best-known example of an early philosophy of technology is that introduced by Heidegger (1977). For Heidegger, the general existence of technology in society has led to the consideration of all things around us as resources that we use without appreciating the reality of the resources' contribution to environmental sustainability. For instance, the external beauty of a tree does not attract businesspeople who work in the timber business; instead, they think of how many planks or pencils they can get from the tree. The process has become evident in our perception of reality. This notion is supported by France and Compton (2012), who described technology as upholding 'process ontology'. Process ontology allows the categorisation and description of components of any product and the relationship between them that makes up a process. From such an ontological point of view, France and Compton commented, "We are creators of the material world of technology in clear and tangible ways, but are also symbolic creators of the world as a whole" (p. 3). They also argued that the role of technologists, in this case, was to interact with available resources to be improved and used to meet the needs of communities.

The epistemological basis of technology is a major factor that is used to determine the nature of technology. In the previous discussion about the nature of science, we understood that the scientific knowledge in science attempts to make claims to 'truth' and this knowledge represents the epistemological basis of science. In fact, knowledge in science is discovered and prepared by scientists to be used by technologists who use it to design and produce products for the use of mankind (Harlen & Léna, 2011). Hence, using scientific knowledge in practice helps to reveal the nature of technological technology. This transformation of scientific knowledge to technological knowledge creates a contentious question: Is technology just the application of science? This question will be discussed in the following section on the nature of the relationship between science and technology.

Technological knowledge is a major component in shaping the concept of technology and its purpose is different to that of scientific knowledge. According to Compton (2004a), the purpose of technological knowledge is not to make claims to 'truth' in the same manner as scientific knowledge does; instead, technological knowledge attempts to understand the process of function. Compton (2004a) also argued that technological knowledge is validated by success, whereas the truth validates scientific knowledge. Wiggins (2012) provided other terms for technological knowledge, including practical knowledge

(knowing how), scientific knowledge, and propositional knowledge (knowing that). He stated that we may be unable to practice practical knowledge without sometimes connecting it with propositional knowledge. McCormick (1997) called these types of knowledge conceptual knowledge (“knowing that”) and procedural knowledge (“knowing how”). He argued that the “knowing that” is conceptual knowledge concerned with tracking facts to explore the relationship between items of knowledge. Conceptual knowledge simply allows us to explain why things happen, while the “knowing how” is attributed to technology, which simply means how to do it. Despite the different features of conceptual and procedural knowledge, the two forms have an interrelationship that McCormick (1997) sees as crucial and effective in solving problems in science or mathematics.

France and Compton (2006) explained that the nature of technology, technological knowledge and technology practice work together to support the concept of ‘technological literacy’. They indicated that the nature of technology provides an explanation of how technologies occur and how they are influenced by historical, social and cultural dimensions. Technological knowledge provides an explanation of technological practice and technological outcomes. Compton (2004b) identified two categories of knowledge: (1) tacit knowledge or implicit knowledge, and (2) explicit or focal knowledge. Tacit knowledge is knowledge that can not be shared and articulated with others; “it is embedded in the subconscious” (p. 3). Tacit knowledge consists of beliefs and values that shape our understanding of the world, while explicit knowledge can be easily articulated and shared with others. Custer (1995) identified two types of technological knowledge: tacit and analytical. *Tacit knowledge* is beyond verbal expression and is processed by craftspeople who are highly skilled in technology. *Analytical knowledge* is where the technological knowledge is processed through scientific knowledge and functional knowledge that offer mathematical solutions for the technological product under process. The body of the technological knowledge includes three components that McGinn (2010) identified: knowing how to do, resources, and methods. The first component refers to knowledge of how to do certain things by using specific material products or by transforming specific material objects. This component is about “knowing how to do”. The second is the knowledge of the resources used in technological activity. This type of knowledge requires that technologists understand the nature of these resources and the properties of materials selected for any technological product. The third component is the

knowledge of methods used in reaching the anticipated outcomes of the technological activity.

In summary, the key three criteria identified in the previous headline (purpose of science, the ontological stance and the epistemological aspect) to discuss the nature of science are also appropriate to discuss the nature of technology. These factors help us understand the purpose of technology, how different views are constructed about technology, and the type of knowledge (technological knowledge) that technology adopts.

3.12.4 Nature of the relationship between science and technology

Philosophers and experts have discussed and addressed the nature of the relationship between science and technology and attempted to distinguish between the disciplines and to understand the relationship between them. A good understanding of the relationship between science and technology is relevant for shaping appropriate concepts of each in both science education and technology education. This section discusses this issue by providing some perspectives derived from the relevant literature.

The literature suggests that the argument about the relationship between science and technology focuses on two key issues. One is the issue of the distinction between the disciplines, and discusses similarities and differences. The other concerns whether technology is applied science.

The first issue relates to confusion regarding whether science and technology are two distinct domains with their own knowledge bases, or if they are same thing and do the same job (Van Den and Van Keulen (2011). This issue has led many researchers to investigate this topic to identify the relationship between science and technology and, thus, remove the ambiguity that caused that confusion. Brook's (1994) metaphor of the two strands of deoxyribonucleic acid (DNA) is the most appropriate illustration in the literature of the relationship between science and technology. As a scientist, Brook argued that the relationship between science and technology is parallel and connected knowledge that has existed over time; the domains can exist independently but cannot produce functional results until they are paired. He also stated that science contributes to technology in at least the following six ways.

- 1- New knowledge that serves as a direct source of ideas for new technological possibilities.
- 2- A source of tools and techniques for an efficient evaluation of feasibility of designs.
- 3- Research instrumentation such as laboratory techniques and analytical methods used in design and technological practices.
- 4- Practice of research is a source for improvement of new human abilities useful for technology.
- 5- Creation of social and environmental knowledge that has become important for technology in relation to its wider influence on the environment and society.
- 6- A scientific knowledge base that offers more efficient strategies of practical research for new technologies.

Brook argued that the converse impact of technology on science appears in two ways: extending the agenda of science through providing new scientific inquiries after putting previous scientific discoveries into practice, and as a source of instrumentation and techniques required to process the scientific enquiry in a sufficient manner.

De Vries (2001) suggested that the history of industrial research laboratories provides a good opportunity to investigate the complex relationship between science and technology. He believed that a good understanding of this relationship is necessary to formulate the concept of science and technology education. He indicated three different interactions patterns of this relationship derived from the history of industrial research. Firstly, between 1900 and 1940, *science was an enabler for technology*. At this time, there was a narrow relationship between science and technology that existed in one direction when a laboratory developed new knowledge that supported a company's product diversification. Secondly, between 1945 and 1975, *science was a forerunner of technology*. In a report entitled "Science, the endless frontier," the scientific advisor to the president of the United States reported that science is the basic source of technological progression in the industrial sector. In this period, the general goal of a research laboratory was to focus on fundamental research as a distinctive contribution to technological development. In this period there was a supposition that technology was an applied science. Thirdly, from 1970 to the present, *science has been a knowledge resource for technological developments*. In

this period, a new science–technology interaction pattern has occurred as a result of a number of economic and social changes that changed the policy of research in industrial laboratories. Gardner (1994) argued that this reflects the interactionist view that has united scientists and technologists as teams that work together and learn from each other. Gardner (1994) also identified four possible positions of the science-technology relationship: science precedes technology, technology precedes science, technology and science engage in a two-way interaction, and science and technology are independent.

The first position is that *science precedes technology*. This means that the technological knowledge grows out of the scientific knowledge or, as Gardner (1994) described it, technological fruits fall from scientific trees. This position continued during the second period of the relationship between science and technology identified above by De Vries (2001). In that period, technology was seen as applied science. This view imposed on teachers in general, and science teachers in particular, the task of teaching technology as an application of science. The second position is that *technology precedes science* (the materialist view). This indicates that technology had existed historically prior to science, as evidenced by ancient artefacts. Based on this view, Gardner argued that the historical and ontological argument (that technology precedes science) has had an educational influence on educators. In this case, educators choose students who have technical skills to perform scientific activities for the purpose of technological innovation. The third position is that *technology and science engage in a two-way interaction* (the interactionist view). This position brings scientists and technologists into one arena of science and technology to exchange scientific and technological knowledge and, between them, to produce useful solutions for their communities. This view will help to break down the boundaries between science and technology and will lead to design content that assists teachers to teach them either together in the classroom or separately while retaining the connection between their content. The last position that Gardner identified was that *science and technology are independent*, with different goals, methods and outcomes (the demarcationist view). This view considers science and technology as distinguishable fields that have different goals, methods and groups of people who have different skills and knowledge. Sparkes (1993) discussed the differences between science and technology: these are summarised in Table 3-1.

Table 3.1: Summary of the differences between science and technology

Criteria of differences	Science	Technology
Goals	To pursue knowledge and understanding for its own sake	To create technological artefacts and systems to meet people's wants and needs
Knowledge introduced	Scientific	Technological
Way of processing knowledge	Through experimentation and theory creation	Through design, invention and production as implementation of theory in science
Reductionism & holism	Breaking and isolation of materials to explain the phenomenon	Integrating theory, ideas and data to for the design purpose
Value judgment	Value-free	Value-laden
Conclusion & decision	Takes time to obtain more data if the current data is insufficient	Product has a deadline and technologists can make a decision based on incomplete data
Research	Search for new knowledge and understanding through controlled experiments	Search for development of products by searching for the principles underlying better processes

Source: Sparkes, 1993.

Contrary to the demarcationist view, which stresses the differences between science and technology, McCormick and Banks (2006) asserted that there are some obvious similarities between science and technology in terms of three dimensions: both offer hands-on learning, both claim to support problem-solving, and both attempt to encourage students to be involved in authentic learning by linking school activities to useful learning that students need in their daily life and the future needs of the work-place. Such a view has led some countries, such as the Netherlands, to consider technology and science as two mutually constitutive practices (Van Eijck & Claxton, 2008). In addition, such an understanding of the intimate relationship between science and technology has influenced the developers of science and technology curricula. For instance, based on the discussion about the fundamental strands of learning science from kindergarten to Grade 8, Van Den

and Van Keulen (2011) categorised the skills and attitudes that teachers need to teach primary science and technology into the five following categories.

- 1- Knowledge of important concepts and theories;
- 2- Knowledge of the nature of science and technology;
- 3- Knowledge and skills concerning inquiry and design;
- 4- Scientific attitudes (curiosity, respect for evidence, creativity, perseverance, critical and open mind), and
- 5- Knowledge and skills with regard to teaching and learning science and technology (pedagogical content knowledge).

However, while these are general skills that teachers need to teach science and technology, there are also specific skills required in each subject that teachers need to be aware of. In order to teach science well, science teachers should acquire knowledge about science theories and about the nature of science, inquiry skills, skills in developing hypotheses about events, data gathering skills, observation skills, interpretation data skills and pedagogical content knowledge skills. In terms of technology, teachers should acquire knowledge in technology theories, the nature of technology and pedagogical content, and acquire skills in design, problem-solving, processing materials and in using tools and equipment.

Similarly, in the Arabic literature, Al-Khateeb (2000) asserted that science and technology are not a single subject; they have different activities, although these can depend on each other. Al-Khateeb explained that it is difficult to discuss technology without some reference to science and vice versa. In his book, entitled *Teaching Technology in Public Schools* (2006), Fath-Allah declared that the differences between science and technology can be understood by looking at the goals and the outcomes of each discipline. The goal of science is to know why and the outcome is to produce theories and laws; the goal of technology, on the other hand, is to know how, and the outcome is to design and to make products.

There is a common conception among educators that technology is applied science; this is the second issue that escalates the controversy between advocates of science and advocates

of technology in terms of the relationship between science and technology. Jones (2007) referred to the issue of the narrow view of technology that is portrayed in science curricula. This view posits that technology is fully applied science. Gardner (1994) argued that this concept is sometimes used as a definition of technology or a general judgment of the relationship between science and technology. The impact of this concept has penetrated schools and has caused most teachers to believe that technology is applied science. In New Zealand, for example, a study conducted by Jones and Carr (1992) showed that all teachers understand technology in terms of the application of science. This issue led us to ask: Is technology just the application of scientific knowledge? Naughton (1993) claimed that the answer to this question is “no”, which he supported by giving numerous examples of activities that are purely technological. He used the construction of Durham Cathedral in the 11th and 12th Centuries as an example of a great technological achievement. The builders did not have scientific knowledge about the properties of the materials used to build the cathedral but they were still able to solve problems that they encountered. He asserted that the cathedral builders applied the knowledge they had inherited from their ancestors that shapes what is called “craft knowledge”; that is, knowledge acquired through practical experience (Brown & McIntyre, 1993). Naughton’s position was supported by Custer (1995), who provided examples confirming technology is not applied science. The first example is the fact that stone-tool manufacturing flourished for over two million years before the development of the mineralogy and geological disciplines. The second is that the development of the cotton gin and steam power were technological achievements before they were developed using modern scientific methods.

Lebeaume (2011) offered in-depth analysis of the issue regarding the belief that technology is applied science. He believed that the confusion about the experimental approach in its epistemological and pedagogical aspects of science and technology made it difficult to clearly define technology education. He disagrees with the researchers who believe there is no difference between the experimental aspects of technology education and science, and he also disagrees with De Vries. He cited De Vries (2005), who explained that technology education is not simply about the method of experimental science but about the foundation of practical science. Accordingly, Lebeaume argues that technology is not applied science but it contributes to develop the praxis of science. In addition, pedagogical confusion arises when teachers cannot distinguish between the epistemological point of view of science and technology (what pupils learn in each

subject) and the pedagogical activities of science and technology (what pupils do in each subject). De Vries (2001) encouraged educators to use the historical material of science and technology as a pedagogical strategy for teaching science and technology. Applying this strategy could help science and technology teachers draw a line between the purpose and the contents of the two subjects.

Jones (2007) claimed that “teaching technology education as a sub-subject to science will be inadequate to help students to understand the role of technology in society.” To address this issue, Jones suggested that the introduction of the concept of science, technology and society (STS) can enhance the learning of science and technology in relation to society and thus help students to expand and to develop a more robust understanding of the combined impact that science and technology have on society. This concept of STS was one of the three main streams identified by Layton (1990, cited in Lebeaume (2011)) regarding how technology exists alongside science: namely, technology as applied science, experimental approach of devices, and the science-technology-society concept. The latter concept, science-technology-society, helps students to understand science and technology within social, cultural, economic and political contexts, and this concept has recently been expanded as science-technology-society-environment (STSE), which addresses environmental, moral and ethical issues (Hodson, 2009).

3.12.5 Ethics in science and technology

Teaching science and technology often raises controversial ethical issues that require teachers to be conversant with scientific and technological ethics. Thus, teachers should have sufficient knowledge about ethics in science and technology so that they can present these ethical issues in the classroom. Reiss (2003) stated that ethics is “a branch of knowledge just as other intellectual disciplines, such as science, mathematics and history” (p. 15). Elsewhere, Reiss (1999) quoted some positive aspects of teaching ethics in science from Davis (1999). Teaching ethics might tend to heighten students’ ethical sensitivity and ethical knowledge, improve their ethical judgment and help make them more virtuous or otherwise more likely to implement normatively right choices.

In terms of ethics in technology education, it has become clear that values and technology education are merged and interwoven (Custer, 2007). Custer argued that it has become practically impossible to disengage technology and its forms from ethical implications

because ethics and values shape and lead demand for new technologies and they reflect what we apprise. He also identified some ethical topics in technology education presented by the technology teachers: the environment and conservation, consumption and consumerism, appropriate technology, the impact of technology on social structures, and the impact of technology on individuals. Custer considered these topics to be very important ethical issues because they represent arenas of significant public debate and concern and are generally within the range of awareness of technology educators.

3.12.6 A framework for understanding the relationship between science and technology

Based on the above review, technology and science can be seen as separate disciplines that have overlapping and interacting elements. As such, they will require different curricula, although an understanding of the relationships should improve the teaching of each. Almutairi's (2014) model of the relationship between the two (see Figure 3.1, below) shows this separation but also indicates points of interaction. The two major divisions (the first for key aspects of science, the second for technology) represent the argument presented in this thesis that the two fields need to be considered as distinct. However, the linkage between the two fields is represented by arrows; again, these are based on the preceding review. An understanding of these components and the relationships between them should provide teachers with a framework to support the development of curriculum and teaching plans. This section provides an overview of the components of the model and further details about the proposed points of interaction.

The top arrow between the two fields represents an important feature of the relationship between technology and science; namely, that scientific knowledge sometimes develops from improvements in technology. Science teachers who understand the limits of testing scientific theories will be better able to inform their students about such theories. Although many theories have been developed from testable hypotheses, some major scientific theories were sound and justifiable before technological advancements provided the tools for formal testing. For example, some of the main elements of Einstein's theories have only been tested recently because the tools have only now been developed to allow such formal empirical testing. Indeed, technological limitations meant that many theoretical physicists of Einstein's time were decades ahead of formal testing of their views. Developments in telescopes/microscopes, computing and computer modelling, lubricants,

fuels and the machines to extract and process them, etc. have all led to the ability to test and extend scientific theories. Models that neuroscientists developed of how the brain works were based on information from post-mortems and brain damage prior to the invention of brain-imaging instruments. An understanding of the difference in the tools available to scientists should lead to improved understanding of how theories have developed, why some theories that are odd by today's standards were perfectly plausible when they were proposed, and how current theories also have limitations. For example, even though brain-imaging techniques have advanced scientific understanding of how the brain works, the tools have certain limitations, such as time-limited testing and highly restricted movement in most cases. Hence, testing of theory is still highly limited by technology. An awareness of this relationship between science and technology should allow the modern-day teacher to understand some of the limits in scientific theory.

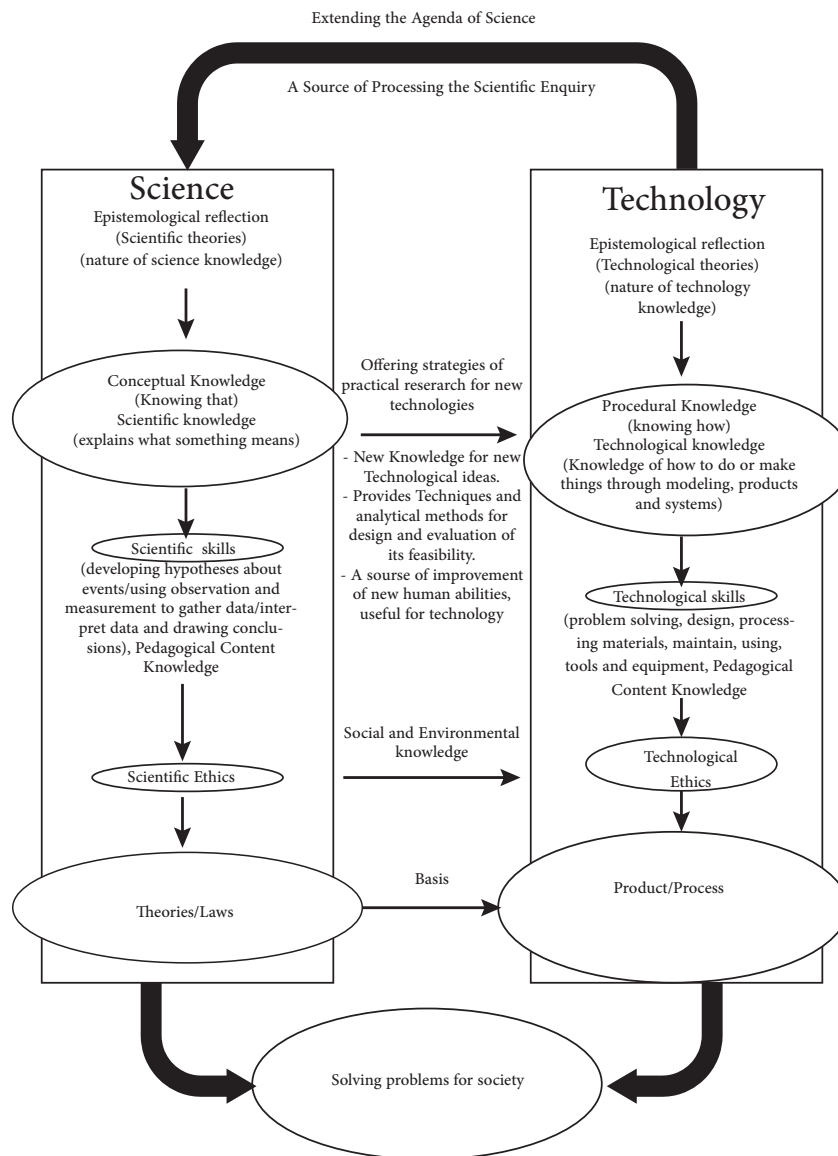


Figure 3.1: Almutairi’s model of the relationship between science and technology. Source: Almutairi, A., Everatt, J., Snape, P., & Turnbull, W. (2014). Exploring the relationship between science and technology in the curriculum. *Australasian Journal of Technology Education*, 1, 49–63.

Similarly, a technological need may lead to scientific advancements. Areas of scientific knowledge may have some gaps that appear odd because the needs at the time were elsewhere. Present-day improvements in scientific understanding of how materials interact have much to do with the need to develop structures that can withstand assault; and modern environmental science is as much technological advancement as pure theoretical testing. However, theory and tools will both clearly be bound by the needs of society. Hence, the arrows at the bottom of Figure 3-1 serve as a reminder that both scientific theory and technological advancement in such areas as environmental science will be limited, or motivated, by societal views about its importance and the success of the solutions developed. Again, an understanding of these inter-relationships will provide teachers of both science and of technology with tools to better understand their students.

Technology is also advanced and limited by scientific knowledge – as represented in the smaller arrows in the middle of Figure 3.1. Teachers of technology would be limited if they did not understand some elements of the theories that led to the development of a tool/product. However, even the simple process of production is often bound by what we would see as scientific methods. It is rare for production techniques to focus on random trial and error. Production typically follows the principles by which scientific methods are bound. The methods for testing a theory are highly related to the methods that would be used to develop and test a product. Even when a product is based on improvements in that other product, the methods used for refinement and effectiveness assessment are typically those recognised by scientific enquiry. Although technological production might be bound by financial requirements and goals, few investors would not demand at least some evidence that a scientist would recognise – and few products would end up in a market without at least some history of scientific testing. Indeed, ethical considerations that are often used as the basis for allowing products onto a market can find their origins in scientific theory. As examples, using a representative sample to test a product is based on mathematical theory, animal testing of new drugs is based on biological theories about relationships across organisms, and even the view that a product or process should not cause harm can be traced back to the bases of medical science theory and practice. Hence, knowledge, theories and even skills developed in science will form a basis upon which to develop technological advancements. Again, teachers who have an understanding of these relationships should be better able to impart understanding to their students, along with the ability to seek further knowledge.

Any developed model can be criticised by people with different understanding and interpretation of the relationship between science and technology. For instance, one could argue that that technology in the present model should also have conceptual knowledge that is not limited to science. While I agree with this argument, the model indicates that conceptual knowledge is significantly connected with science that aims to interpret the events based on theory, while procedural knowledge is a remarkable characteristic associated with technology that aims to use theory and laws (conceptual items) to create technological products.

3.13 International Technology Education

Investigating a technology education concept in any context, especially in one with less experience in teaching technology, should include information that shows how technology education is implemented in countries that include it in their curriculum and have experience in this field. International literature will help inform later discussions and conclusions. This thesis aims to explore and discuss the situation of technology education in New Zealand as an appropriate model (as justified in Chapter 2) and Saudi Arabia. This discussion will be more effective if it is supported by international point of views.

3.13.1 Technology education in the United States

In 2011, the International Technology and Engineering Educators Association (ITEEA) developed a new model to teach science, technology, engineering, and mathematics (STEM) for grades K–12. The model provides technological literacy in a STEM context. Engineering by Design (EbD) was integrated into this model that generally aims to provide technological study in facilities that are safe, stimulate creativity, and enable all students to meet local, state, and national technological literacy standards. This model has many goals.

- Provide a standards-based K-12 program to develop students' technological literacy.
- Provide opportunities for all students, female and male.
- Provide clear standards for developing student academic achievement in science, technology, engineering and mathematics.
- Provide leadership and support that will produce ongoing development and of the program.

- Restore America's reputation as the leader in innovation.

The programme is organised around 10 principles. These are general concepts that identify key content organisers for the programme; they are directly quoted from ITEEA website.

1. Engineering through design improves life.
2. Technology and engineering have affected, and continues to affect everyday life.
3. Technology drives invention and innovation and is a thinking and doing process.
4. Technologies are combined to make technological systems.
5. Technology creates issues and impacts that change the way people live and interact.
6. Engineering and technology are the basis for improving on the past and creating the future.
7. Technology and engineering solve problems.
8. Technology and engineering use inquiry, design and systems thinking to produce solutions.
9. Technological and engineering design is a process used to develop solutions for human wants and needs.
10. Technological applications create the designed world.

Schools developing themes in the STEM and IT clusters are adopting the EbD programme, as they are aiming to enhance student achievement in STEM and English through authentic learning. Awareness and competence are developed through constructivist models, upon which the programme is built. This is because it enhances learned knowledge and skills, aligning closely with knowledge and skills in both the STEM and IT clusters.

ITEEA (2011) explained: "The EbD Program was designed to maintain integrity through two delivery scenarios: Pathway program, where schools adopt the articulated sequence of courses in a STEM and/or an IT-themed academy. Modularizing the components and adapting the design themes to support the STEM, IT, or other academy models. In this scenario, as in many career-themed academy models, some modification is required to ensure themes are aligned with the cluster of Knowledge and Skills" (ITEEA website).

Table 3.2: Content of Technology Education Model for K–12 in the United States

K–2	EbD-TEEMS
3–6	EbD-TEEMS 1
6	Exploring Technology
7	Invention and Innovation
8	Technological Systems
9	Foundations of Technology
10–12	Technology and Society
10–12	Technological Design
11–12	Advanced Design Applications
11–12	Advanced Technological Applications
11–12	Engineering Design

3.13.2 Technology education in England

According to Morgan et al. (2013), design and technology (D&T) has been a part of the national curriculum in England since 1989. Its formation and the evolution of the subject from traditional craft aspects (woodworking, metalworking, home economics, and sewing) toward a more design-centred approach was an education policy innovation. This approach was reviewed in 2011, intending to replace the curricula with one based on the best school systems in the world. This review proposed to slim down the national curricula, setting out only essential knowledge for pupils. This threatened the future of D&T as a separate subject, but these recommendations of the Review Panel were eventually rejected.

In 2013, the government published the draft programmes of study for D&T in the National Curriculum for Key Stages 1–3. However, these draft programmes significantly shifted the direction of D&T: in place of a design-centred curriculum, there is now a strong emphasis on practical life skills. The government indicated: “We recognise the importance of life skills for children and young people but strongly oppose the way they are positioned within the draft D&T curriculum” (Morgan, Jones & Barlex, 2013, p. 6).

The Department for Education (2013) indicated that the national curriculum for D&T in England aims to ensure that all pupils achieve the following.

- develop the creative, technical and practical expertise needed to perform everyday tasks confidently and to participate successfully in an increasingly technological world

- build and apply a repertoire of knowledge, understanding and skills in order to design and make high-quality prototypes and products for a wide range of users
- critique, evaluate and test their ideas and products and the work of others
- understand and apply the principles of nutrition and learn how to cook (Department for Education website, 2013, p. 1)

In England, D&T is believed to be important, as it is one of the few subjects in the curriculum in which pupils are presented with problems and can solve them without only one right answer. This allows pupils to build confidence and provides them with practical skills, such as team work and collaborations, which help them be creative and innovative.

The structure of D&T consists of four sections: Design, Technology, Critique, and Data. In the Design section, pupils should understand that designing involves responding to a need, want, revision or new opportunity by generating a concept that is then developed and refined to where it can be brought into physical existence as part of the made world. In the Technology section, pupils should understand that technological activity involves using practical intellectual resources to develop products and systems that expand human possibilities by addressing needs and taking opportunities. Innovation and adaptation are fundamental to technological practice. Technological thinking should be informed, critical, and creative to lead to desirable outcomes. Technology has its own particular knowledge and skills, and uses those of other disciplines in pursuing its goals. In the Critique section, pupils should understand that standing back and looking at the outcomes of design, technology, and engineering involves making an assessment of their worth from a variety of perspectives (such as global, social, cultural, economic, and environmental). In the Data section, pupils use data to inform a design as a critical part of any design process, whether it is undertaking customer surveys to design new furniture, taking measurements to design a kitchen, or undertaking experiments to design the appropriate shape of an aeroplane wing.

3.13.3 Technology education in Finland

In Finland, the subject of technology education is called Craft. The Finnish National Board of Education (2004) stated that the task of teaching in crafts is developing pupils' skills to then increase their self-esteem. In addition, their sense of responsibility for the work and the use of the material will improve. Students learn to value the quality of the material and

work and take a critical, evaluative perspective toward their own decisions, ideas, and products. The instructional tasks in crafts must be clear “to guide the pupil in systematic, sustained, independent work, and to develop creativity, problem-solving skills, an understanding of everyday technological phenomena, and aesthetic, technical, and psychomotor skills” (p. 240).

In Grades 1–4, the core tasks of crafts instruction are to teach handicraft skills and knowledge of crafts, and awaken pupils’ critical faculties, sense of responsibility, and awareness of quality in their work and choice of materials. The pupils get help in assimilating basic design skills and gain capabilities by realizing their designs. They are guided in the safe and appropriate use of the various machines and the basic tools needed in crafts. Their perseverance and problem-solving skills are developed both in group and independent work. Diversified work, skill development, and the experience of knowing how to awaken joy in the work, help the pupil acquire a positive attitude toward working and studying. The instruction is implemented with the same content for all pupils, and encompasses technical and textile work. Within Grades 1–4 the pupils will achieve the following (Finnish National Board of Education, 2004, p. 240):

- Get to know concepts associated with crafts and learn to use a variety of materials, tools, and methods
- Adopt a positive attitude toward occupational safety. Learn the safe use of tools, machines and equipment, and learn to be comfortable in their learning environment
- Learn about basic crafts techniques and planning crafts products, and become practised in the required skills, so as to develop their thinking skills and creativity
- Learn spatial perception in designing and making processes
- Learn to pay attention to aesthetic properties, colours, and forms of products
- Learn to make, take care of, and repair everyday products
- Learn to take responsibility for their environment of objects, and understand that products have life cycles
- Get introduced to the use of information technology tools in the different phases of design and making processes, and in a variety of learning environments
- Gradually come to master an entire crafts process
- Gain an introduction to the technology of day-to-day life
- Learn to evaluate and appreciate their work and that of others.

In Grades 5–9, the core task of crafts instruction is to increase and deepen pupils' knowledge and skills in crafts, so that they can appropriately choose materials, techniques, and tools at different phases of the crafts process. The pupils are encouraged to self-directedly innovate, design, and work. They are guided in valuing the quality of work and material. The pupils' cooperative skills are developed by carrying out joint projects in groups, in conjunction with representatives of different school subjects and the local working, industrial, and cultural communities. The instruction encompasses core technical and textile work content. In addition, pupils may be given the chance to emphasise either technical or textile work, according to their interests and inclinations. In Grades 5–9 students will achieve the following (Finnish National Board of Education, 2004, p. 242).

- Learn to design and produce high-quality, aesthetically pleasing products suited to their purposes, and to give consideration, when working, to ethical, ecological, and economic values
- Familiarise themselves with Finnish and other peoples' technological, design, and crafts cultures, thus acquiring ideas for constructing their own identities and design tasks
- Familiarise themselves with skills and knowledge that are associated with traditional and contemporary technology and can be applied in day-to-day life, further studies, future job tasks, and pastimes
- Learn to appreciate and critically examine their own work and that of others, and to find, both individually and cooperatively, creative solutions to the problems they perceive, using various information source as an aid
- Learn to take a position on technological development and its meaning for the well-being of individuals, the society, and nature
- Come to understand entrepreneurship and industrial production processes

3.13.4 Technology education in New South Wales, Australia

In 2014 the New South Wales (NSW) Government announced that in 2015 schools will teach the new NSW Science K–10 (incorporating Science and Technology K 6) Syllabus to all students in K–6 and Years 7–10.

There are three main areas of science and technology education the NSW government lists on its official website (2014). Teaching in these areas will help students study the following.

Values and attitudes to:

- develop an appreciation of the contribution of science to finding solutions to personal, social and global issues relevant to their lives now and in the future
- develop a willingness to use evidence and reason to engage with and respond to scientific and technological ideas as informed, reflective citizens
- develop interest and positive, informed values and attitudes towards science and technology
- recognise the importance and relevance of science and technology in their lives now and for their future

Skills to:

- develop knowledge, understanding of and skills in applying the processes of Working Scientifically
- develop knowledge, understanding of and skills in applying the processes of Working Technologically

Knowledge and understanding to:

- develop knowledge of the Physical World, Earth and Space, Living World and Chemical World, and understanding about the nature, development, use and influence of science
- develop knowledge of the Natural Environment through understanding about the Physical World, Earth and Space, and Living World
- develop knowledge and understanding of the Natural Environment and the Made Environment through the Material World
- develop knowledge and understanding of the Made Environment through Built Environments, Information and Products

In each area the students move through six stages of learning: early stage one, stage one, stage two, stage three, stage four, and stage five. By the end of each stage there are expected outcome as follows:

Early stage one: by the end of this stage students can develop knowledge about the natural environment and the made environment is fostered through purposeful play, observing, questioning and exploring ideas.

Stage One: Students can describe situations in which technology is used in everyday life and respond to questions, while investigating ways that science and technology can help sustain the environment through the use of Earth's resources.

Stage Two: A willingness to improve local environment is increased as students show greater interest for science and technology. Students will recognise and appreciate the importance of science and technology in their lives.

Stage Three: Students show interest in local, national and global issues, maintaining a sustainable future, and how science and technology can be used to solve these issues. Students can discuss how science and technology affect people's lives and display informed understanding about the current and future use of science and technology.

Stage Four: Students can identify questions and problems that can be scientifically tested or researched. This allows students to engage with the processes of working scientifically, as they can choose different strategies to reach creative and plausible solutions to identified problems. Students, individually and collaboratively, plan and conduct a range of first-hand investigations, including fieldwork and controlled experimental methods.

Stage Five: Students' understanding of the world will increase as they actively use the processes of working scientifically. Understanding of science ideas and concepts are developed as students participate in scientific inquiry. Their understanding of how scientific knowledge is refined over time and the significance of scientific evidence in evaluating predictions, claims and explanations will also increase.

3.14 Technology Education in New Zealand

Harwood (2002) suggests that there have been three distinct eras in the development of technical/technology education in New Zealand: (1) Technical education pre-1975, (2) technical/technological education between 1975 and 1995, and (3) technology education from 1995 to the present. The present study focuses on the third period because it involved the major development of technology education and included a clear meaning of this subject that was widely investigated by experts and researchers.

3.14.1 Key developments in technology education from 1995 to the present

In the New Zealand curriculum, ‘technology’ refers to the separate subject of technology as it is taught in New Zealand schools, while ‘technology education’ refers to the theoretical foundations that help technology teachers to teach. The Ministry of Education (1995b) defined technology education as “a planned process designed to develop students’ competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of technological society” (p. 7) In addition, Jones (2003) suggested that “technology education usually focuses on technology as ‘process’ that is learning in which design and making things is important” (p. 89). Thus, technology education provides an opportunity for students to learn about the processes and knowledge related to technology as a subject.

The New Zealand Curriculum Framework (Ministry of Education, 1993a) provided an overarching framework for the development of curricula in New Zealand and defined seven broad essential learning areas rather than subject areas (Jones, 2003). Technology was included as one of these seven learning areas.

The 1993 Framework was followed by the first draft of a technology curriculum (Harwood & Compton, 2007). This draft was developed and released to schools, with feedback sought from educators at the end of 1993 (Ministry of Education, 1993b). The final edition, *Technology in the New Zealand Curriculum* (Ministry of Education, 1995b) “was officially launched in late 1995 and gazetted in February 1999 as mandatory for all schools from Years 1–10” (Harwood, 2002, p. 12). The delay in implementing such curriculum changes was probably due to the Ministry of Education’s desire to give schools time to make the necessary changes.

Technology in the New Zealand Curriculum (1995b) stated that the aim of technology education in New Zealand was to expand students' technological literacy. This aim was linked to three "interrelated learning strands" (Compton & Harwood, 2005, p. 256): "The aim of technology education is to enable students to achieve technological literacy through the development of Technological Knowledge and Understanding, Technological Capability and Technology and Society" (Ministry of Education, 1995b). These three strands "needed to be brought together in all technology programmes to ensure students were provided with opportunities to undertake technological practice" (Techlink, 2008).

However, after more than 10 years of implementing the 1995 curriculum in schools from Years 1–13, Techlink (2008) reported how the Ministry of Education had needed to introduce technology practice because it had not been clear in the 1995 curriculum. They said:

It has been noted that the nature of the technological literacy resulting from students undertaking technological practice alone was often limited in breadth and depth. It was also often lacking the level of critical analysis required for more informed decision-making in students' own practice and, in particular, making choices of a more general nature with regards to technology per se. (n.p)

Therefore, it was decided to review the 1995 strands by considering some studies that aimed to clarify their limitations. According to Techlink (2008), this research led to a realisation that technological practice strands on their own were not sufficient for developing students' technological literacy, and further research was recommended to identify what might be absent and to remedy those gaps. This resulted in the revised *Technology Curriculum in the New Zealand Curriculum* (Ministry of Education, 2006).

Compton and Harwood (2006) noted, "a strong sociological focus was argued as key to supporting student technological practice, in order to move technological literacy away from a 'functional' orientation to a literacy that was 'Liberatory' in nature" (p.1). Moreover, as Compton and France (2006b) explained:

The review showed that relying on technological practice alone often resulted in a shallow and narrow technological literacy that was unable to support a level of informed critically [sic] the 1995 curriculum had aimed for. To redress this, it was argued in 2004,

that there needed to be a stronger focus on the philosophical basis of technology and identified generic technological knowledge.
(p.2)

Based on these factors, the development team for technology decided to improve the aim and amend the concept of technology education as part of the New Zealand Curriculum Marautanga Project. The overall aim of technology was not changed: it remained focused on developing students' technological literacy, but the change was in the concept of technological literacy underpinning this aim (Compton & Harwood, 2006). This new concept of technological literacy had evolved from the 1995 technology curriculum to enable students to develop a literacy that was deeper, broader and more critical in nature. This evolution was explained by Compton and France (2006b) in the way that the three 1995 strands had been modified in the curriculum.

3.14.2 The structure of the learning area in New Zealand

The New Zealand Curriculum (Ministry of Education, 2007a) clearly stated that the learning area of technology “comprises three strands: *Technological Practice*, *Technological Knowledge*, and *Nature of Technology*. Teaching and learning programmes will integrate all three, though a particular unit of work may focus on just one or two.” The Ministry also identified technological areas including structural, control, food, ICT and biotechnology.

Knowledge and skills were to be learned in context. By offering a variety of contexts, teachers would help their students recognise links and develop generic understandings. Students should be encouraged to access relevant knowledge and skills from other learning areas.

3.14.2.1 Technological practice

According to the Ministry of Education (1995b), in the technological practice strand students examine the practice of others and undertake their own. They develop a range of outcomes, including concepts, plans, briefs, technological models and fully realised products or systems. Students investigate issues and existing outcomes and use the understandings they have gained, together with design principles and approaches, to inform their own practice. They also learn to consider ethics, legal requirements, protocols, codes of practice, and the needs of and potential impacts on stakeholders and the

environment. Compton and Harwood (2003) explained that technological practice is a developing concept within technology education in New Zealand. It is currently defined as an overall descriptor for the thoughts, actions and interactions that occur as part of any technological endeavour (Compton & Harwood 1999a; Compton 2001; Ministry of Education 2001, cited in Compton & Harwood, 2003, p. 3). There are six factors of technological practice that should be considered within any context (Compton & Harwood, 2003). These are as follows.

- 1- The perspectives of the people involved in the development
- 2- The capability of the people involved in the development
- 3- The range of technological knowledge, skills and resources available at any time
- 4- Knowledge and skills from other domains as appropriate
- 5- The society and environment that impact upon the development
- 6- The society and environment that the development will impact upon (p. 4)

Moreover, Gawith (1999) emphasised the importance of developing knowledge about how to organise and manage the development within a societal context when he defined technology practice as “the process of improving existing products, or developing new products while at the same time managing the tension between the constraints of society and technological development” (p. 2). Gawith also clearly linked technology practice with a problem-solving approach. He believed that technology practice included six general aspects about the way technologists approach and carry out their practice. These aspects were:

- A series of problem-solving type activities
- A purposeful process that is focused on achieving a solution
- A systematic, rational approach that endeavours wherever possible to quantify and record in order to ensure repeatability, reflection and quality assurance
- A process of constant decision and compromise on the part of technologists
- A disciplined application of innovation, flair and creativity
- An ability to consider self-practice and alter and improve the processes, techniques and methodologies used.

Finally, Gawith asserted that these aspects of technology practice can be effectively implanted if teachers recognise the elements of technology practice that specifically help students to learn the basic principles and techniques of technology and how to apply them to work and society. Additionally, students must learn how to be organised, and how to extend their ideas and technical skills. This involves developing an understanding of society's needs and learning research skills (both scholarly research and market research).

In reporting findings of classroom research project (*Technology Education Assessment in Lower Secondary*) conducted over two years (1999 & 2000), pointed out that there are three components of technological practice that have occurred as a result of technological practice activities undertaken by students. These components are: *brief development, planning for practice, and outcome development and evaluation* (Harwood & Compton, 2007).

Teaching *brief development* provides students with the opportunity to discover the values of other cultures by identifying a real need that is based on a comprehensive examination and critical analysis of context, related issues, and a wide range of consumers' values and needs (Compton, 2006). This component also asks what should be done and why. These questions, in my opinion, highlight the importance of understanding the role of *tacit knowledge* in technology education that "is embedded in the subconscious" (Compton, 2004b, p. 3).

The *planning for practice* component highlights the importance of taking care of the environment and helps students develop ethical decisions and deal with appropriate resources around sustainable development. Compton (2006) considers the on-going reflection and evaluation of past practice factors to be critical to this component, in that it helps students explore their own and others' values and develop an understanding of how these values influence the process of decision-making.

The final component in technological practice, *outcome development and evaluation*, was explained by the Ministry of Education (2007a) as:

“the development of a technological outcome (product or system), or any other outcome of technological practice concepts, plans, models, etc.” and it involves the creative generation of design ideas and the refinement of potential outcomes. This is achieved through on-going research, experimentation, analysis, testing and evaluation against the specifications of the brief. Developments should be based on the evaluation of the functional modelling undertaken during practice and prior to the realisation of the outcome. Refinement of a realised technological outcome should be informed by evaluations from prototype testing *in situ*, in order to optimise its fitness for purpose. Outcome development and evaluation can be thought of as the trialling and production practices of technological practice.” (p. 2)

3.14.2.2 Technological knowledge

Through the technological knowledge strand, students develop specific knowledge concerning technological enterprises and environments and understandings of how and why things work. Students learn how functional modelling is used to evaluate design ideas and how prototyping is used to evaluate the fitness for purpose of systems and products as they are developed. An understanding of material properties, uses and development is essential for understanding how and why products work the way they do. Similarly, an understanding of the essential parts of systems and how these work together is necessary for understanding how and why systems operate in the way they do (Ministry of Education, 2007a).

This strand includes three components: *technological modelling*, *technological products* and *technological systems*.

Technological modelling involves learning how to create functional models and prototypes for products before evaluating and further developing them (Ministry of Education, 2007). Evaluation is a valuable learning process whereby students can develop an understanding of usefulness, market needs and production processes.

Functional modelling allows for the ongoing evaluation of design concepts for yet-to-be-realised technological outcomes. Prototyping allows for the evaluation of the fitness for purpose of the technological outcome itself. Through technological modelling, evidence is gathered to justify decision-making within technological practice. This modelling is crucial for the

exploration of influences on the development, and for the informed prediction of the possible and probable consequences of the proposed outcome. Technological modelling is underpinned by functional and practical reasoning. (Ministry of Education, 2007b, p. 50)

The *technological products* component relates to materials and their usefulness for product development. Students should develop their ability to evaluate materials in terms of their best usefulness (Ministry of Education, 2007b). These developments will include:

Understandings of new materials formulation and their potential impacts on future product function. The impact of material use and development on product life cycles/expectancy is also included with regards to understanding material sustainability in its broadest sense. (p. 58)

The last component, *technological systems*, was explained by Compton and France (2006a) as an understanding of how product components work together.

Technological systems consist of interconnected components designed to work together to control the transformation of materials, energy and information. Understanding how the components work together is as important as understanding the nature of the individual components. (p. 10)

Students will develop their ability to understand technological language and key concepts such as input, output, transformation and control (Compton & France, 2006b, p. 10). Students need to develop the ability to critically evaluate possible areas of redundancy or on-going reliability in a technological system's design. Teachers also need to help students to understand the hidden processes and workings of everyday products (*ibid*).

3.14.2.3 Nature of technology

The nature of technology is a theoretical strand that aims to help students distinguish the subject of technology from other disciplines. Students learn how their lives have been affected by technology, particularly as it has evolved, and they explore how such developments have historically affected various groups in society (Ministry of Education, 2007a). Such investigation leads to valuable critical thinking: "As they do so, they come to

appreciate the socially-embedded nature of technology and become increasingly able to engage with current and historical issues and to explore future scenarios” (p. 32).

As students reach the senior secondary level, this strand helps them integrate technology with learning from other subject areas. “For example, students working with materials and/or food technology will need to refer to chemistry, and students working on an architectural project will find that an understanding of art history is invaluable” (*ibid*).

Compton and France (2006a) identified two components of the nature of technology: *Characteristics of technology* and *technological outcomes*. They defined the first component as “a purposeful intervention by design: human activity that can result in technological outcomes that impact the world” (p. 6). Technology enables certain activities that lead to particular outcomes; specifically, those that convert, store, transfer and manage materials, energy and information (Compton & France, 2006a). I believe that, through this component, students should understand the historical development of technology because it will help them to observe the development of our ability as human beings to invent what we want to facilitate in our lives.

The second component, *technological outcomes*, is defined as the material products developed for a particular purpose “through technological practice” (*ibid*). Technological outcomes have two interconnected elements – *physical* and *functional nature* that can be described when they are embedded in their socio-cultural and chronological contexts (Compton & France, 2006b). A technological outcome is evaluated in terms of its fitness for purpose through two stages. The first is the proper function that is applied to explain the designer’s intended function. The second stage is an ‘alternative’ function, which is developed by clients in ways not planned by the designer (*ibid*).

3.15 Technology Education in the National Curriculum

3.15.1 Technology education in Saudi Arabia

As mentioned earlier, technology education has not been clearly identified in the Saudi Arabian primary school curriculum. An intensive search of the websites of the Ministries of Education in Arab countries such as Egypt, Jordan, Saudi Arabia and Qatar revealed that this subject has not been included under this title. While Egypt does have two subjects

taught at Years 4, 5 and 6 related to science and technology, each subject has its own title (“industry” and “agriculture”) (Ministry of Education in Egypt, 2010). In addition, ICT is the only application of technology education that is used and taught in these countries as an independent subject without it being referred to as technology education. Furthermore, Bahrain has recently introduced technology and design as a separate subject in primary schools.

There is a significant lack of literature that discusses this subject or that even suggests how this subject should be taught in Arab schools. I found only two textbooks that shed light on this modern subject: Fath-Allah (2006) and Mazen (2009). The first discussed technology education extensively in several respects (explained later), while the second defined technology education and explained some of its features.

Mazen (2009) defined technology education as knowledge and skills that humans depend on, which in turn depends on the education system and the current technological ways that are known as ‘technological revolution’. Mazen went on to say that this technological revolution is a plan to meet community needs, which starts from training about thinking skills through the development processes of handicrafts to achieve individual and community goals. The definition given by Mazen is, in my view, relatively broad; it focuses only on the conceptual aspect of technology education rather than the procedural factor mentioned by Fath-Allah (2006). The latter defined technology education in the sense that technology is human activity that emphasises the study of technological systems and their fundamental elements and includes tools, materials, knowledge, skills, individuals, energy, time and funding. Fath-Allah went on to say that the teaching of technology aims to provide students with information about the technological world that is managed and produced by inventors, engineers, innovators and other specialists. For instance, students can learn about how energy is produced from coal, natural gas, nuclear power, winds and solar energy. The subject also helps students investigate communications systems such as telephone, radio, TV, satellites and Internet, and they can learn how to search for information and transfer it through using these technological devices.

Technology education, as seen by Mazen (2009), is a major component of curriculum components that include scientific skills, intellectual skills and practical skills, which in

turn include teaching technology. Mazen identified the following five characteristics of technology education content.

- 1- Technology content that focuses on information related to technology.
- 2- Technology implementation that depends on technological processes that assist in solving implementation problems, as well as design and development as part of theoretical base of technology education.
- 3- Technology in connection with other subjects.
- 4- Manual work principle: Technology education stresses respect for manual tasks with continuing emphasis on using modern technology to develop manual works to avoid the full dependence on human efforts.
- 5- The relationship between technology and society: technology education sheds light on technological topics that have a direct influence on society. Technology education also helps individuals remain involved with and contribute to their community via technology, and to fill gaps that have emerged as a result of technological changes.

Mazen (2009) suggested the following six themes related to the content of technology:

- 1- Technology applications in technology education;
- 2- Using robots;
- 3- Industrial practices, light, lasers, visual fabric, etc.
- 4- Communications technology;
- 5- Technology and the academic curriculum, and
- 6- Technology in the future.

Similarly, Fath-Allah (2006) suggested what content should be included in technology education. Figure 3-2 shows the themes that Fath-Allah suggested for teaching technology in an Arabic environment. The author used and analysed international models that helped him to create his own model. He explained that this diagram includes four dimensions that reflect the meaning of technology education in an Arabic context and that it represents the philosophical framework of technology education. In addition, it helps to choose, organise, treat, and evaluate educational situations that include teaching technology.

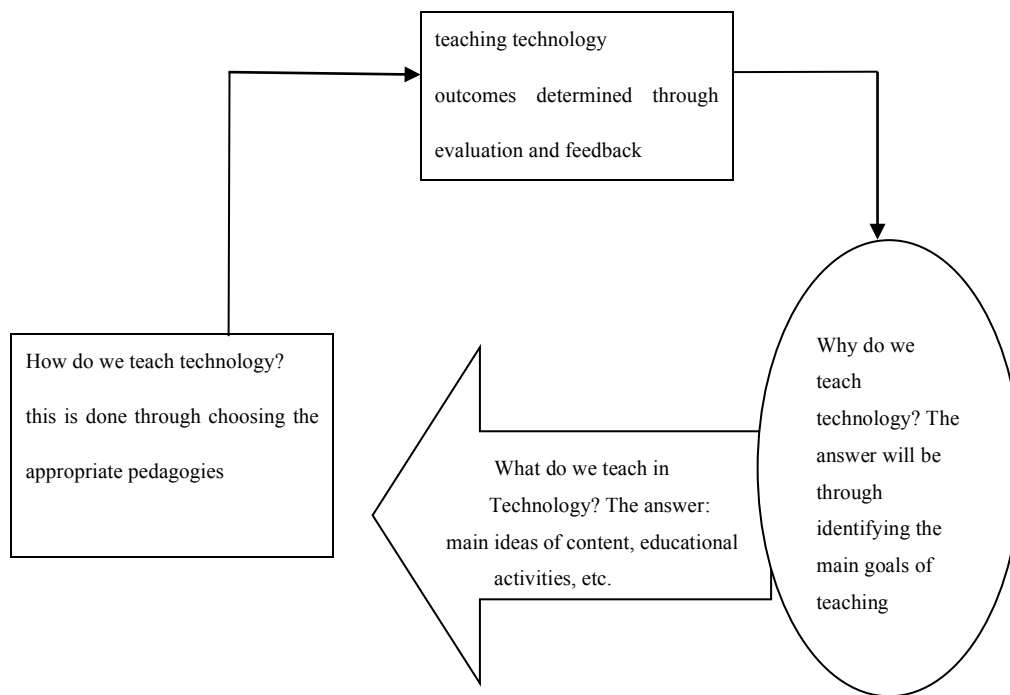


Figure 3.2: Themes suggested by Fath-Allah (2006) to teach technology in an Arabic environment

The diagram includes the major questions related to teaching technology (why, what and how) that the present study is attempting to answer in order to create a model of teaching technology in Saudi Arabia.

Fath-Allah indicated that the main goal of teaching technology is to achieve cognitive, mental skills (*knowledge*); affective skills, which is growth in feelings or emotional areas (*attitude*); and psychomotor skills, which is manual or physical skills (*skills*) by helping students to:

- Know the features of systems (input, processes, output)
- Develop their ability to discover and use technological resources
- Develop their creative thinking in studying and analysing problems
- Increase self-confidence to make decisions
- Apply mathematical and scientific concepts related to technology, and
- Appreciate handicrafts and respect those who practice them.

These objectives can be achieved through applying three kinds of activities identified by Montclair State University (2001, cited in Fath-Allah, 2006); namely, capability tasks, resources tasks and case studies. The first activity aims to help students improve their designing skills in various fields such as transportation and building. The second activity aims to help students use available resources that enable them to complete their tasks and also to find out which resources are unavailable in order to improve the discovery learning amongst students. Finally, case studies are authentic activities that students observe to help them to understand how technology works in real-life situations. For instance, students can understand how a radio receives signals and how a picture appears on television.

Abo-Almati and Yousef (1999) indicated certain reasons why they feel it is essential to teach technology:

- To help citizens understand technology that might affect their life in a negative or positive way;
- To help citizens work together to help the world, and
- To help students and citizens deal with a huge amount of information that cannot be controlled without understanding technology.

I conducted an extensive search of large libraries in Saudi Arabia, such as the King Abdulaziz General Library, the King Saud University Library, the King Abdulaziz University Library, and Um Aqura University Library. I found that most of the relevant literature discussed the following areas: ICT, instructional aids, and educational technology. This confirms that there has been ambiguity regarding the concept of technology education. However, the new subjects planned for primary schools that the MoE introduced in 2010 include a new subject called “occupational education.” This subject is linked to art under one title (“Art and occupational education”), while science is an independent subject. Based on this plan, I suggest that integrating the two subjects reflects the situation in Saudi Arabia whereby technology education has been understood as a supplementary subject of art (see Table 2-1). In addition, the MoE has included the subject “occupational education” to meet claims that society has been teaching subjects that help prepare student for the current technological era. Unfortunately, this subject has not been accompanied by an interpreted document that shows why, what and how this subject is implemented in primary schools. Similarly, science subjects in the primary

curriculum include several topics related to technology but they are referred to as science due to the absence of the technology concept in the Saudi curriculum. For instance, the general objectives to teach science at the primary stages include the following statement: “It is expected at the end of this stage that a student acquires practical skills such as making a simple phone and to make a model of an electronic circle” (Ministry of Education, 2003, p. 28).

The content of science of primary education was evaluated by Al-Ghamdi (2012) with the aim of identifying the standards and the indicators that can be used to analyse the content of a science curriculum. The study also aimed to evaluate the developed science curriculum according to these standards and indicators. Al-Ghamdi identified seven domains in science and technology, 20 standards, and 86 indicators. The seven domains are: (1) science as a method of investigation, (2) physical science, (3) life science, (4) science and technology, (5) science from personal and social perception science, (6) nature and history of science, and (7) Earth and space science. Al-Ghamdi also identified three indicators that can be used to analyse science curriculum in terms of the science and technology domain. These indicators are: (1) skills development of technological teaching, (2) understanding the relationship between science and technology, and (3) understanding applications of science and technology. Al-Ghamdi analysed science textbooks of lower classes, Years 1, 2 and 3, based on the indicators, related to the science and technology domain. These indicators were mentioned 96 times: 25 times for skills development of technological teaching (26 percent), 55 times for understanding the relationship between science and technology (57.3 percent), and 16 times for understanding applications of science and technology (16.7 percent).

3.16 Teachers’ Perceptions of Science and Technology Education

Educators should consider teachers’ opinions and experiences that play a key role in improving the educational environment. “Teachers’ perceptions, worldviews, experiences, and subcultures all play a significant role in shaping technology education’s stance with respect to sustainability and the environment” (Elshof, 2009 p. 233). The research on primary teachers’ perceptions of science and technology has attracted a great deal of research attention in recent decades (Asma, Dermolen, & Aalderen-Smeets, 2011). However, more studies of teachers’ professional needs and perceptions were carried out in

Western societies than in Arab societies (Mansour, Alshamrani, Aldahmash, & Alqudah, 2013). There is also a general lack of Saudi teachers' voices in the science and technology literature (Al-Ghamdi & Al-Salouli, 2013).

Some research has been conducted internationally and nationally to determine the impact of teaching technology from the perspectives of technology teachers. A summary of this earlier work conducted in New Zealand and other countries, and nationally in Saudi Arabia, produces a background to the present study. In terms of the Saudi context, I conducted an extensive search and found few studies that explored Saudi science teachers' perceptions about science and technology.

3.16.1 Studies conducted in New Zealand

In this section, both primary and secondary data provide a more comprehensive review of relevant data on the topic.

Jones and Compton (1998) conducted research in 14 classrooms with 14 technology teachers. It involved the researchers working with four full primary teachers (one teaching Year 1 students, two teaching Years 2–3 students, and one teaching Years 5–6 students). The other teachers were involved in post-primary education: five intermediate teachers (all teaching Years 7–8 students), and five secondary teachers (two teaching Year 9 students, three teaching Year 10 students). In this research, the process of working with teachers took into account their perceptions of technology, technology education, existing ideas of teaching and learning, needs and expectations, and classroom experiences in technology. The study found that the introduction of the 'new' learning area in schools – that is, technology – was problematic. Teachers' sub-cultures in terms of teaching and learning, a specialised subject area, as well as the school itself and its concepts of technology, all influenced the development of the classroom environments and strategies. Subsequent student activities, classroom observation and teacher interviews suggested that technological knowledge, an understanding of technological practice and an appropriate conceptualisation of technology and technology education were important within the learning area of technology education. However, Jones and Compton suggested that, in order to introduce technology into the classroom, it is important to have not only a developed concept of technology but also an awareness and understanding of technological

activity. Further, teachers will need to experience technological practice and techniques in some form before they become confident in the teaching of technology.

The study also reported on the final stage of the three-year Learning in Technology Education (LITE) research project funded by the New Zealand Ministry of Education (Jones and Carr, 1992). That earlier study investigated teachers' perceptions of technology as part of the project, based at the Centre for Science and Mathematics Education Research at the University of Waikato. In that project, 30 teachers (16 full primary teachers and 14 secondary teachers) were interviewed to examine their perceptions of existing technology education. Many teachers used their experiences, both in and out of school, to construct a perception of technology education. A comparison of the findings of the two studies indicates that, since technology was a new learning area, teachers' knowledge of their own concepts of technology as a separate subject was unclear and limited (Jones & Carr, 1992). In contrast, after five years of teaching technology, primary and secondary teachers' awareness of the concept of technology as a learning area was evident and clearly influenced by the cultural dimension in schools. Jones and Compton (1998) identified that, prior to 1995, both primary and secondary teachers had been unable to view and reflect on their practice from their notion of technology. Therefore, Jones and Compton concluded that "their concept of technology would be problematic due to the non-consensual nature of technology education presently held by teachers" (p. 53).

Similarly, Paechter (1991) argued that teachers (at both primary and secondary levels) have a personal view of the practice of teaching within their concept of subject learning. This view has been referred to as a subject sub-culture and has led to a consensual view about the nature of the subject, the way it should be taught, the role of the teacher, and what might be expected of the student (cited in Compton and Jones, 1998).

I believe that establishing a clear theoretical framework for technology in New Zealand (Ministry of Education, 1995b) has played a role in promoting teachers' understanding of technology in schools. Technology should be taught based on a theoretical foundation rather than merely teaching skills. Students today need to learn how to design for the public's need, rather than how to follow orders perfectly and to satisfy teachers.

Gass (2007) identified two types of technology teachers: qualified technology teachers and teachers who have had to update their areas of expertise from traditional methods to modern techniques. The second group often focuses on method rather than theory, and therefore need professional development to help them fit their experiences to the needs of today's technological processes. This is a key issue to address in order to improve technology teaching. Gass also argued that principle must underlie practice and link to work as whole "like a pair of scissors cutting the edge" (p. 8).

Two different teachers' development programmes have been developed and used in the New Zealand context: Facilitator Training and the Technology Teacher Development Resource Package. Compton and Jones (1998) examined these programmes to evaluate their outcomes. They noted that the participants who were primary and secondary teachers considered it important to develop a theoretical background in the area of technology education: "Some of their comments highlighted the fact that they did not think the theoretical aspects were particularly relevant initially, but they appreciated their importance later, when undertaking professional development activities of their own" (p. 158). That study also supported the idea that a professional development programme helps technology teachers develop their understanding of the concept of technology. Sixty-three percent of respondents (primary and secondary teachers) in their study found that the programme assisted them with their understanding of the concept of technology. The researchers suggested that six key features should be taken into account when developing technology education teacher professional development programmes (for primary and secondary teachers) consistent with the New Zealand national curriculum statement in technology. These key features stressed the importance of developing a strong concept of technology and technology education, an understanding of technological practice in a range of contexts, technological knowledge in different areas, technological skills in different areas, an understanding of how prior experiences shapes understanding of the concept of technology education, and an understanding of how technology education can occur as an essential learning area. Gass (2007) argued that while developing the concept of technology, the position of technology education should clearly indicate whether the technology curriculum is asking teachers to teach principles rather than practice, process rather than product, knowledge rather than skill, design rather than action, and planning rather than doing.

The New Zealand Curriculum 2007 appears to help students understand the principles before the practice. They can learn how to make a plan for any product and design products based on appropriate processes. This reflects that the new concept of technology does not separate knowledge from skills but instead encourages teachers and students to practise skills based on systemic knowledge.

Jones and Moreland (1998) reported that there have been developments in primary and secondary teachers' perceptions of technology and technology education since 1993. Teachers then have much broader concepts of technology and technology education, and act in accordance with the technology curriculum. However, greater teacher understanding is required of technological concepts and procedures in the various technological areas.

Harlow, Jones and Cowie (2004) investigated primary and secondary teachers' experiences of the implementation of the technology curriculum in New Zealand schools from Years 1–13. These academics sought to explore how effective the curriculum is in practice and they also discussed how their findings can inform future developments. A sample of 10 percent of all types of New Zealand schools (both State and Private) was required for Jones, Harlow and Cowie's (2004) study. Teachers were asked many questions to determine how useful they had found the technology curriculum statement. Questions covered areas such as the structure of the curriculum, the support and professional development for technology teachers, assessment and reporting issues, and strategies for curriculum implementation. The results provided a broad sweep of information about teachers' experiences, and the general impression was that most teachers were reasonably positive about teaching based on the curriculum statement. In that study, over 40 percent of primary teachers declared that the curriculum statement was always or sometimes helpful in planning their classroom activities. In addition, primary teachers used the technology curriculum statement for guidance on curriculum levels more than secondary teachers. Also, 50 percent of teachers for Years 9–13 wanted to make changes to the structure of the technology curriculum statement. They partly identified what these could be, finding that the most popular changes would be 'making it simpler to understand' and 'including better developed learning and assessment examples'. In addition, most primary and secondary teachers (64 percent) believed that technology should be compulsory for all students to the end of Year 10; they felt that it provides students with important life skills like communication and problem-solving skills.

Moreover, the study identified four major challenges for primary and secondary technology teachers. Half of the teachers in the study considered that the main obstacle to teaching technology was the lack of equipment needed to implement the technology. Adding another burden on teachers as a result of introducing technology to schools was the second major challenge. This point was identified by 32 percent of all teachers (particularly primary teachers), who complained about the ‘crowded curriculum’. Twenty-two percent of teachers emphasised a lack of professional development in technology education as a major challenge. The fourth major challenge was to understand the curriculum (22 percent); this percentage is identical to the percentage of teachers who lacked professional development.

Almutairi (2009) investigated teachers’ perceptions of technology education (two full primary teachers and two secondary teachers) in Years 7 to 10 in New Zealand. In that study, teachers acknowledged that technology is a unique subject that helps students move from abstract learning to constructive and concrete learning. The conclusions of that study also supported earlier studies in terms of how teaching technology made a significant and positive change to students’ technological literacy.

3.16.2 Studies conducted in Saudi Arabia

Saudi Arabian science teachers’ and supervisors’ views of professional development needs were explored by Mansour et al. (2013) to identify their needs for both pedagogical and content knowledge. This was a first step toward making decisions and recommendations about the element of professional programmes required for science teachers. A total of 499 science teachers and 61 supervisors of science teachers were involved in that study. The teachers were asked about their professional development needs concerning science content knowledge and needs in pedagogical knowledge and skills. Their responses were compared to the responses of the supervisors. Mansour articulated that the findings of his study indicate that the concept of technology was not explicitly pointed out by the teachers and the supervisors but instead was implicitly included among the professional needs mentioned by both groups, such as structure and properties of matter and the solar system and universe. He also believed that this study reflects the current concept of science and technology education in the Saudi curriculum.

Al-Ghamdi and Al-Salouli (2013) conducted a study to explore science teachers' beliefs about the process of teaching and learning science and also to explore their views about a new Saudi science curriculum. That new curriculum was introduced in 2008 by the Ministry of Education in collaboration with Obeikan Research Development Company and the American McGraw-Hill Company. The new curricula "adopt a teaching approach based on the constructive theory of learning with an emphasis on critical thinking and problem-solving" (Al-Ghamdi & Al-Salouli, 2013 p. 504). Six females and four males were interviewed as participants in that study. The participating teachers generally felt the new curricula was interesting in that it encouraged students to think, argue and discuss scientific concepts that had previously been treated strictly as a series of facts. However, they experienced some difficulties with the internal barriers, lack of external support and professional development. These findings indicate that science education reform is a systemic issue in which sponsors, advocates, change agents and targets of change must work together to achieve the development and implementation of the innovation. That study clearly illustrated the importance of a coordinated effort by the Ministry of Education, school administration, regional supervisors and teachers to plan, design, and deliver support to classroom teachers. The support should take the form of pre-service courses, professional development workshops, self-directed learning, and daily mentoring, focused on teachers' beliefs and associated classroom practices related to teaching and assessment. One of the main conclusions of that study was the need for the Ministry of Education to review public policy relative to the time allocated to teaching science or the prescribed topic coverage in each grade level. All public school teachers indicated that having only two periods of science instruction per week was insufficient for achieving student-centred approaches and critical thinking and problem-solving outcomes across the required topics.

3.16.3 Studies conducted in other contexts

Teachers' perceptions about technology education have been investigated internationally. For instance, a national survey among teachers conducted by the Association of Swedish Engineering Industries in 2005 showed that teachers were uncertain about technology as a school subject (Barbutiu, 2011). That survey reported that it was not easy for teachers to express the syllabus that should be taught in technology education classrooms.

Eighty-four teachers were involved in a focus group discussion conducted by Asma et al. (2011) to examine professional and personal attitudes of teachers to teaching science and technology. The major goal of that study was to determine whether teachers perceive a distinction between their professional and personal attitudes towards science and technology. This study involved three groups: teachers who were not involved in any professional development programme, teachers who had little training, and teachers who had elaborate prior training in science and technology. The results showed that teachers in the three groups were almost equally positive about science and technology in relation to positive cognitive and affective factors, but that those teachers who had little or no professional development in science and technology had considerable negative remarks regarding the negative cognitive factors. The context factors were developed based on the authors' practical experiences and the literature. The results showed that many teachers who had no or little training in science and technology had negative attitudes towards implementing technology. The teachers attributed these attitudes to a structural factor caused by a lack of school support and insufficient school organisation and other external obstacles, such as a lack of equipment, time and financial support, and the long lead-in time they need to arrange a good environment to teach technology. In terms of self-efficacy, the teachers did not reveal particularly negative attitudes towards their capability to teach technology.

Denessen et al. (2011) involved 139 primary school teachers from 36 Dutch primary schools and measured their attitudes towards science and technology. The results showed that the teachers in this sample reported quite positive attitudes towards science and technology, on average, although there were some gender differences. Male teachers reported significantly higher scores regarding their enjoyment of teaching science and technology than female teachers, and also reported higher levels of perceived competence. Both genders rated their motivation to invest in their science and technology teaching competencies equally highly. Analysis of gender-stereotyped attitudes showed that only one teacher rated one of the items on the right-hand side of the rating scale (4 and 5), indicating that the science and technology was more applicable to girls than boys, while other teachers indicated that science and technology is applicable to both boys and girls.

3.17 Implementing Technology Education in the Classroom

It is essential that students are taught meaningful topics and that they are engaged in thought-provoking discussions in order to reach the maximum benefit of teaching and learning in the education environment. This is done by applying new teaching and learning strategies. Teaching students through old-style pedagogies is not sufficient for teaching the new generations (Snape & Turnbull, 2013). This point of view had been presaged by Petrina (2007) who claimed that it is not enough to involve students in theoretical activities without providing them with practical activities. Snape & Turnbull and Petrina believed that students' knowledge and skills must be articulated by using modern teaching strategies such as design, problem solving, and creativity.

This section sheds light on modern teaching strategies which have been suggested or applied to promote technology education. The focus is on three aspects: modern strategies, individual differences of students in the classroom, and authentic activities. I selected these areas because they are key elements in the evaluation of teaching and learning in the technology education classroom and they were extensively discussed in the literature.

3.17.1 Modern strategies to technology education

Gray and Smith (1998) identified six effective teaching/learning strategies that enable students to achieve the goals of technology education. The first strategy is ingenuity challenge, which provides a way for students to (1) develop and practice problem-solving methods; (2) develop and apply their ingenuity, creativity, and thinking skills; and (3) develop technological skills based on skills learned in mathematics, science and arts. The second strategy is topical investigation, which helps students learn how they investigate a particular technological issue that relates to a central theme. The third strategy is using a modular activity package, whereby students are divided into teams of two students. Each pair is exposed to several short technological activities that should be completed within a specific period over the term (for example, one week for each activity). Such activities require hardware, such as computer-assisted instruction and audio-visual media. The fourth strategy is product generation, which provides students with skills related to processing food, clothing, and shelter. According to Gray and Smith, these skills make students more productive and make their lives more enjoyable. The fifth strategy is research and experimentation, which provides students with the experimental method as

one of principal research methodologies. The final strategy is engineering design and development, which helps students identify a problem related to technology in nature and then develop a solution by designing a suitable product to solve the problem.

A recent study conducted by Turnbull (2013) aimed to investigate the nature of conversation in technology in the classroom. The study took place in a New Zealand primary school and focused on 12 students; six in each of Years 2 and 6. This study identified four over-arching elements of conversation: funds of knowledge, making connections and links, management of learning, and technology knowledge and skills. Turnbull declared that these elements describe the sources and the purpose of conversation. For example, conversations identified as funds of knowledge showed that students brought prior experiences from home and their community to their technology learning. In making connections and links, students implemented knowledge from what they had learned in school. Management of learning that reflects techniques and strategies that teachers and students use to improve learning. The fourth element is technological knowledge and skills that bring together the three previous elements. After further analysis, Turnbull joined the first and second elements into a “deployment theme.”

De Vries and Koski (2013) investigated system thinking as an application of technological knowledge. They explored students’ understanding of: (1) a system as a structure consisting of main and subparts; (2) inputs and outputs that they consider important for a system; and (3) the boundaries of a system. Twenty-seven primary pupils from Years 8–10 were selected for that study, which included a pre-test for the teacher and the pupils, lesson planning, the actual lesson and a post-test for the pupils. The study revealed that the pupils showed some understanding of machines consisting of parts with different functions, or that a sequence of steps is required to complete a process. However, the students described the system as the experience of the user instead of parts of a machine that work together. Students found the concept of input to be more understandable than output. The challenge that the students faced was setting boundaries to systems, which the researchers attributed to the students being confused between the role of the system and the role of the user.

In 2007, a research group at the Department of Education at Stockholm University conducted the Exemplary Tasks in Technology (ETT) research project. This project aimed to produce exemplary tasks in technology to be used in classroom to improve teaching

technology (Barbutiu, 2011). The project engaged a number of teachers in technology who could implement the tasks in their classes; at the end, they evaluated the process of the implementation. The teachers were later interviewed to understand their views of implementing technology in their classes. According to Barbutiu (2011), the design of the exemplary task was based on British experiences. That research covered several areas in technology education; in the present section, I will focus on findings related to implementing technology in classroom. The teachers understood their role as technology teachers as including three main aspects: increasing students' interest in technology, showing them how things work, and talking about technology. I believe these roles reflect two key concepts that teachers should consider in technology education: the procedural and conceptual concepts. Dakers (2007) argued that the procedural concept is about technological knowledge, while the conceptual concept concerns the development of knowledge about technology. He also suggested that the two concepts be combined to produce the technological literacy concept.

3.17.2 Considering individual differences of students in the classroom

Hoepfl (2007) asserted that individual differences among students, including cultural and intellectual aspects, may need to be considered when designing learning experiences to help students to succeed. She claimed that all teachers, including technology teachers, must adopt strategies to enable them to more effectively teach all students. She used Thelma Kastl's strategy of teaching technology as an example of how technology education teachers consider differentiated instructions in classroom. Kastl is a technology education teacher in the United States who believes that differentiated instruction in the technology classroom is about the key ideas of a unit, lesson, and knowing about individual students and their capabilities through informal and formal assessments. However, Hoepfl (2007) indicated that time constraints will not help teachers to work closely with every student and he believed that setting a simple and useful strategy, such as that suggested by Tomlinson and McTighe (2006). They asserted that teachers should pay attention to aspects that reflect students' needs and every aspect can be addressed through a specific strategy to ensure that way of teaching benefits students. Hoepfl (2007) summarised the general strategies for addressing common needs in the classroom in the table proposed by Tomlinson & McTighe (2006, pp.97–99).

- 1- *Need reading support*: Examples of suggested strategies include highlighting essential passages in text, and giving the option to use reading “buddies”.
- 2- *Have difficulty paying attention in class*: Suggested strategies including using multiple modes when presenting material and using cooperative groups strategies like Think-Pair-Share.
- 3- *Students have different strengths or ability levels*: Provide advanced materials that explore content more fully, encourage independent study, and use learning contracts to personalise content and tasks. These are examples of suggested strategies of this aspect.
- 4- *Need targeted instruction and practice*: Suggested strategies include routinely meeting students in small groups and assign homework that is targeted to individual students’ needs relative to key content.

3.17.3 Technology education enhances authenticity and activity in classroom

Authenticity is an important aspect of teaching and learning in technology education. Turnbull (2002) stated, “By involving our students in an activity that is authentic to technological practice or real-world technology, teachers are able to provide stimulating and relevant learning for students” (p. 23). Turnbull believed that there is confusion among teachers about the notion of authenticity and authentic technological activities for children: the teachers think that the authenticity occurs when they take their students to visit the technologists in their place of work, but this is not sufficient to provide students with authentic learning. According to Johnson (1992), authenticity means that technology teachers need to work as technologists in their classrooms. Solving unfamiliar technological problems is important and teachers should not hesitate to confess if they have made errors through the problem-solving process. This can help students realise that not all problems have straight-forward and simple solutions.

McCormick (1996) declared that technology is an activity more than a subject with content, and that its focus is on ‘doing’. McCormick’s concept of technology education reflects that implementing technology education into the classroom passes through conceptual knowledge and procedural knowledge. He explained that procedural knowledge is close to the idea of ‘know how’, which simply means ‘knowing how to do it’, and this knowledge is linked in the classroom with other concepts such as ‘process’,

‘problem-solving’, and ‘strategic thinking’. ‘Know that’ is conceptual knowledge concerned with relationships among ‘items’ of knowledge.

Solving problems and designs are key strategies in implementing technology into the classroom and they are the main candidates for consideration as procedural knowledge (McCormick, 1997). McCormick (1997) also indicated that technology educators do not have a clear idea of the relationship and distinctions between problem-solving and design, which could challenge them to implement technology education as it should be. I found that the two concepts were clearly discussed by Dan, Williams, Steven and Donald (2007), who stated, “Problem solving seeks to resolve a discrepancy between one’s expectations and the reality of one’s situation. It usually has significant social and affective dimensions in addition to cognitive elements” (p. 3), while design commonly “involves a third-party customer or user, and some hardware, software, or process that satisfies a need. Many people confuse design with *fabrication*. While manufacturing is often a large component of design, design is as much planning, analysis, and documentation as it is physical prototyping” (p. 4). Dan et al. (2007) also identified characteristics of problem solving and design, which I believe will remove the confusion among technology teachers when they apply problem-solving and design.

Table 3.5: Characteristics of problem solving, design, and research

Characteristic	Problem Solving	Design
Purpose	Remove/reduce difference between current and desired situation	Develop a device or system to meet a specific need
Goal State	Agreement or validation that the situation is resolved	Hardware or process that satisfies the customer or user
Starting Point	Undesirable or uncomfortable situation requiring change	Needs analysis, definition of specifications
End Product	Remedial action plan that can often be generalised	Tested artefact, tool or process, including supporting documentation
Time Scale	Days – weeks	Weeks – months
Knowledge Base	Situational expertise	Product expertise
Resources	Journals, newspapers, personal networking	Vendor information, patents, CAD/CAM, design of experiments

Common Implementation Steps	Identify a problem	Recognise Need
	Engage/Motivate	Needs analysis
	Define problem	Target specs
	Explore ideas	Concept design
	Plan solution	Detailed design
	Execute plan	Implement
	Validate	Test/refine

Source: (Dan et al. 2007: p. 5)

3.17.4 Implementation technology education in the Saudi context

In the Saudi context, the Ministry of Education encourages teachers to implement the “Penta-method” strategy to implement science and technology in the classroom. Al-Hatriti and Al-Mazroa (2013) explained that this strategy was a result of integrating learning cycles and concept mapping to one strategy implemented through five steps. The strategy comprises five elements: (1) Preparation – prepare students to be engaged in the discussion (2) Exploration and investigation – students implement activities to explore a particular topic by collecting data about it, and then record the data to be used for the investigation; (3) Explanation and interpretation – students can explain and interpret the data about the topic being investigated; (4) Evaluation – students can evaluate the topic based on elements determined by them and the teacher; (5) Enriching and expansion – students can read beyond what they have learned to expand their knowledge about the topic, rather than depending solely on information given by the school.

Fath-Allah (2006) suggested themes that could be taught in technology education in Arabian classrooms. His suggestion, as illustrated in Figure 3-2, consists of three dimensions: Why do we teach technology? What do we teach in technology? How do we teach technology? The third of these dimensions clearly shows how technology education should be implemented in classrooms. Fath-Allah emphasised the unique role of technology teachers, derived from the philosophy of technology education, which focuses on problem-solving and helps students to consider how they think, not what they think. He suggested some strategies to implement technology in the classroom: an effective collaboration between the learners will give them the opportunity to be involved in certain tasks and they can, through this strategy, show their thinking and intellectual abilities. The second strategy links learning with students’ daily lives: it discusses technological issues

that impact on their daily lives and how they can suggest some solutions for these issues. A third strategy is visiting technological and production sites, which can help students watch technology in action. This direct experience, in my opinion, produces more effective reactions than indirect experience.

3.18 Key Findings from the Literature Review

The central aim of the literature was to explore the situation of technology education based on four aspects that will help me answer the research questions. These aspects are outlined in the following sub-sections.

3.18.1 The relationship between science and technology

The literature showed that the relationship between science and technology has long been debated by scientists, technologists, science teachers, technology teachers, politicians and members of the community in general, who have not been able to reach general agreement on a framework that determines that relationship. The debate has been about whether technology should be considered as an application of or subservient to science. Many articles have been written about the relationship between science and technology, but no framework has been developed that clearly articulates this relationship. The literature inspired me to develop a model that could help teachers identify the relationship between science and technology in order to either integrate the two subjects in the classroom or teach them separately. This model is known as Almutairi's model of the relationship between science and technology (see Figure 3-1).

3.18.2 National and international technology education curricula

The research literature has concentrated on describing technology education for primary schools in five international contexts: the USA, England, Finland, Australia (New South Wales) and NZ. The literature also discussed the subject in national contexts presented in Arabian countries, including Saudi Arabia.

The literature explained that technology education is a modern subject that has been taught in different countries under different titles: technology education in the USA; design and technology (D&T) in England; craft in Finland; and technology education in Australia, New Zealand and in the Arabic literature. The subject is included as an independent

subject in the national curricula of the USA, Finland, England, Australia and New Zealand. In Australia (New South Wales) it is integrated with science. The Arabic literature describing the status quo of technology education in the national context has led me to conclude that this subject has not been included as an independent subject in most Arabian countries. However, the literature has indicated that industrial and agriculture subjects are included in Egypt's national curriculum (primary schools, Years 4–6), and also that design and technology has been included as a separate subject in primary schools in Bahrain. Similarly, in Saudi Arabia, 'occupational education' has recently been introduced to the new subjects plan for primary schools, but without giving a theoretical base to the subject that explains why the subject is taught, what is taught, and how it is implemented. Based on the literature, I can conclude that the Arabic literature has not been able to answer these questions based on any scientific research.

3.18.3 Definitions and goals of technology education

The definition, goals and structure of technology education differed among the above-mentioned countries, which reflects the general philosophy of teaching this subject. However, all these different aspects reflect the technology education concept and its ultimate purpose, which is to improve students' technological literacy. Literature in the Arabian context showed that the goal of teaching technology can be achieved in technology education through helping students to achieve the following goals.

- Know the features of systems (input, processes, output)
- Develop their ability to discover and use technological resources
- Develop their creative thinking in studying and analysing problems
- Increase self-confidence to make decisions
- Apply mathematical and scientific concepts related to technology, and
- Appreciate handicraft and respect those who practise it.

3.18.4 Teachers' perceptions of technology education

Several studies included in the literature explored science and technology teachers' attitudes towards that subject and it was a main goal of most of those studies. Overall, the results provided a broad sweep of information about teachers' experiences. The general

impression was that most teachers were reasonably positive about teaching technology in schools.

The literature showed that teachers emphasised that technological knowledge, an understanding of technological practice, and an appropriate conceptualisation of technology and technology education were important in teaching within that learning area. Teachers now have much broader concepts of technology and technology education, and act in accordance with the technology curriculum. Their awareness of the concept of technology as a learning area was evident and clearly influenced by the cultural dimension in schools. The literature also showed that teachers acknowledged that technology is a unique subject that helps students move from abstract learning to constructive and concrete learning. Moreover, the literature showed that professional development had impacted on the teachers' attitudes. Teachers who were involved in professional development were almost equally positive about science and technology in relation to positive cognitive and affective factors, while teachers who had little or no professional development in science and technology made more negative remarks about the cognitive factors. Also, many teachers who had little or no training in science and technology had negative attitudes towards implementing technology. The teachers attributed that point to structural factors such as a lack of school support, insufficient school organisation and other external obstacles (the lack of equipment, time and financial support, together with the long time they need to arrange a good environment to teach technology). In terms of self-efficacy, the teachers did not reveal significantly negative attitudes towards their capability to teach technology.

3.18.5 Implementing technology education in classroom

The literature showed that old-style pedagogies of teaching technology education have been substituted by many modern teaching methods that comply with the modern teaching and learning. These methods include solving problems, applying skills, making decisions about meaningful issues ingenuity challenge, topical investigation, using a modular activity package, product generation, research and experimentation, and engineering design and development. Such teaching strategies are appropriate to teach technology education that is an activity more than it is a subject with content and its focus is upon 'doing'.

In the Saudi context, there was poor implementation of teaching strategies. It appears that only the “Penta-method” strategy is applied to teach science and technology in the classroom. This method comprises of five steps that aim to prepare students (a) to be engaged in the discussion, (b) to explore a particular topic, (c) to explain the data, (d) to evaluate the topic based on elements determined by them and the teacher, and finally (e) to help students read beyond what they have learned in order to expand their thinking skills.

3.19 Summary

This chapter has provided a theoretical framework for this study. This chapter included the theory used in this study, “critical education theory.” It also reviewed the literature on this subject. The next chapter will focus on the methodology and design of the research.

Chapter 4

Research Methodology

4.0 Introduction

The methodology for this study was developed in order to identify what type of inquiry would help compare technology education in New Zealand with science and technology education in Saudi Arabia curricula. This chapter outlines the research design proposed for this study. A qualitative (case study) approach was adopted, supported by a quantitative approach in the Saudi context.

The research includes the following parts: (1) research paradigm, (2) research approach and (3) research methods. The chapter also includes a study design that comprises strategy, research questions, sampling, data collection and data analysis. Ethical considerations are also included. This study makes a unique contribution to the analysis of technology education in the New Zealand and Saudi Arabia primary school systems. The results of this study could help to reform education in Saudi Arabia in terms of teaching science and technology by disseminating the modern concept of technology education in Arabic education in general, and in Saudi education in particular. The study also contributes to the further development of comparative research in technology education nationally (Saudi Arabia) and internationally.

4.1 The Research Paradigm

Any research should include a paradigm that is defined as a set of basic beliefs (or metaphysics): it represents a world view that defines, for its holder, the nature of the world, that individual's place in it, and the range of possible relationships to that world and its parts (Guba & Lincoln, 1994, p. 107). Sarantakos (2005) identified the following components of the research paradigm.

- *Ontology* deals with the nature of reality, whether it exists “out there” (objective) or constructed (subjective). In this study, the reality is in the minds of people who

work in the field of technology education; it is therefore subjective as seen by the people who deal with it, in the contexts of both New Zealand and Saudi Arabia.

- *Epistemology* deals with the nature of knowledge that helps us understand the way in which reality is known to us. I used the interpretivist epistemology to research reasons for including and teaching technology education. Interpretivism is related to *hermeneutics theory*; a view of meaning that was established in the 19th century. According to Neuman (2003), this theory is largely found in the humanities (philosophy, art history, religious studies, linguistics, and literary criticism). It emphasises the need for a detailed reading or examination of data that the researcher will analyse in order to find meaning embedded within a text as a way of discovering the facts (Guba & Lincoln, 1994).
- *Methodology* is the core of this study. It is a research strategy that shows how the study is constructed and conducted and it also transmutes ontological and epistemological principles into guidelines that show how research is processed (Sarantakos, 2005).

4.1.1 Research approach

To investigate this topic, I used the qualitative approach as a dominant approach for investigation, supported by a quantitative approach in the Saudi context. The mixed methods approach was used in order to produce a valuable study that includes deep and broad knowledge, in order to “capitalize on the strengths of two approaches, and to compensate for the weaknesses of each approach” (Punch, 2005, p. 240) and to provide broadly reliable and consistent data (Bryman, 1988). Qualitative and quantitative data were collected in phases (sequentially). Collecting data in this manner means that either the qualitative or the quantitative data comes first. As Creswell (2003) explained, “It depends on the initial intent of the researcher. When qualitative data are collected first, the intent is to explore the topic with participants at site. Then the researcher expands the understanding through a second phase in which data are collected from a large number of people” (Creswell, 2003, p. 212). The data collection section of this thesis shows the design used to collect the data for this study.

Both approaches reflect the epistemological view within the research paradigm. Neuman, (2003) stated that a qualitative approach is an application of an interpretive view, which is

“the foundation of the social research techniques that are sensitive to context, that use various methods to get inside the ways others see the world, and that is more concerned with achieving an empathetic understanding of feelings and world views than with testing laws of human behaviour” (Neuman, 2000, p. 75). Strauss and Corbin (1990) claimed that a qualitative approach can be used to better understand any phenomenon about which little is yet known. Hoepfi (1997) added that this approach can be used to acquire new perspectives on things about which a great deal is already known, or to gain more in-depth information. This approach helped me acquire rich detail and insights about the current situation of technology education – a subject about which much is already known in New Zealand – in order to inform the Saudi context, where relatively little is known or understood about technology education.

There are four central elements of the qualitative approach identified by Sarantakos (2005) that match my philosophy towards investigating technology education as a phenomenon. The first is *perception of reality*; I believe that the reality of technology education is subjective and resides in the minds of people who work in this field, each of whom constructs their own reality about technology education. The second element is *perceptions*; the participants in the study are active people and they occupy the central position in this study. Their perceptions help to answer research questions, which in turn construct the meaning of the topic being investigated. The third element is *the nature of science*; as the researcher looks at the information that is being gathered, it is not scientific facts but perceptions that represent the knowledge that he is looking for. Science in this case is “not nomothetic but ideographic; it represents reality symbolically in a descriptive form” (Sarantakos, 2005, p. 42). The fourth element is *the purpose of social research*; I employed qualitative and quantitative approaches within social research that aims to explore, understand and interpret the topic of this study.

4.1.2 Research methods and instruments

4.1.2.1 Research design

Punch (2005) explained that the research design refers to the way the problem of the research is identified until its results get reported and published. She cited Denzin and Lincoln (1994) as saying that the research design connects the research questions to the data. Punch defined the research design as “the basic plan for a piece of research” (p. 63)

and suggested that it contained the following five components: (1) strategy (comparative case study), (2) research questions, (3) tools and procedures for collecting and analysing data, (4) sampling and (5) ethical considerations. These components were used to shape the design of the present study and each component is explained in detail below.

4.1.2.2 Research strategy

I used the case study method as a strategy to investigate the topic in depth. Punch (2005) argued that the case study method is an important and distinctive strategy in both qualitative and quantitative research. She explained that “the case study aims to understand the case in depth, and in its natural setting, recognizing its complexity and contexts ... The case study is more a strategy than a method” (p. 144). Denzin and Lincoln (1994) also argued that case studies have become one of the most common strategies to conduct a qualitative inquiry, and they identified three types of case study.

- The intrinsic case study, where the researcher wants a better understanding of a particular case.
- The instrumental case study, where the study undertaken is not the main issue but plays a supportive role and helps to improve our understanding of something else.
- The collective case study, where the instrumental case study is extended to cover several cases. Punch (2005) stated that this type can also be referred to as a multiple case study or comparative case study.

I used the comparative case study approach to describe and to compare the current situation of technology education in primary schools in New Zealand and Saudi Arabia. I believe that this is the most appropriate type of case study to conduct cross-national comparisons in order to reconceptualise the concept of technology education in Saudi schools by developing its content, which has been embedded in science subjects. Comparing the two subjects helps us to learn from the experience of others, improve education at home, and understand what has helped to form the system of international education (Phillips & Schweisfurth, 2014). Other advantages of comparative inquiry include improving knowledge, reforming and developing education, having better understanding about one’s own educational system, and promoting international goodwill (Brian, 1981). Broadfoot (2000) argued that comparative education has a distinctive capability “to make the familiar strange” (p. 357). Pavlova (2005) identified three periods

in the development of comparative research in technology education. In the first stage, people interested in technology education looked to international concepts to develop this subject, although the analytical approaches used were not conducted methodically. The second stage saw the publication and presentation of numerous papers that elucidated the situation of technology education in a particular country. Comparative research was not popular at this stage. The third stage included cross-national comparison, which includes certain aspects of technology education, such as “the meaning of the major concepts, teaching methods, comparison of goals, comparison of the balance between the global trends and local specifics” (Pavlova, 2005, p. 1).

4.1.2.3 Research questions

The focus of the study is to answer the following principal and sub-questions:

How can the experience of New Zealand’s implementation of technology education inform the technology education in the Saudi curriculum?

- 1- How is technology education implemented in the New Zealand primary curriculum?
- 2- What is the current situation of technology in Saudi primary education?
- 3- What are the similarities and differences in technology education in the two contexts?
- 4- What could improve teaching technology education in Saudi primary education?

With regard to the first sub-question, the implementation of technology education in New Zealand was analysed in relation to the following aspects:

- Education policy and the New Zealand curriculum, including understanding the development of technology education in the New Zealand curriculum;
- Exploring how technology education is implemented in classrooms and recognised as good practice; and
- Understanding the perceptions of key individuals regarding technology education.

On the other hand, data was collected from Saudi Arabia in order to help answer sub-questions 2 and 4 of the study, which aimed to explore the current situation of technology education in the primary curriculum of Saudi Arabia through the following activities:

- Documenting technology education in the Saudi primary curriculum;
- Understanding how technology education is implemented in classrooms in primary schools;
- Understanding the perceptions of key people regarding technology education; and
- Producing suggestions that might help to enhance technology education in Saudi Arabia.

4.2 Procedures of Collecting and Analysing Data

4.2.1 Data collection methods

As mentioned previously, I used a combination of qualitative and quantitative approaches to collect data. Greater priority was given to the qualitative approach because it was the main approach of this study and was given greater weight throughout the data collection (Morgan, 1998).

Sequential Exploratory Design (11.2b), developed by Creswell (2003, p. 213) was employed in this study. This is because the present study consists of a qualitative approach in the New Zealand study and qualitative and quantitative approaches in the Saudi Arabia study, which need to be analysed separately. Figure 4.1 below shows the data collection and analysis process.

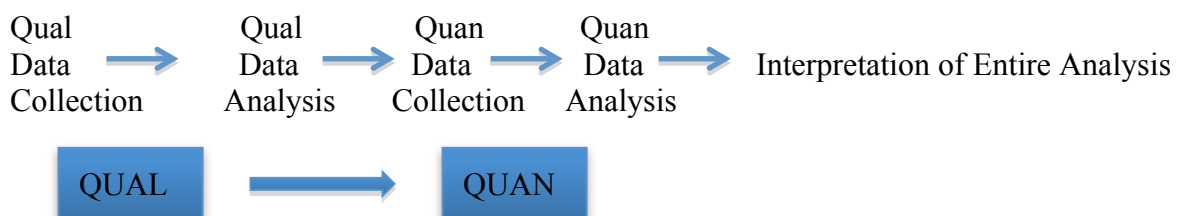


Figure 4.1: Data collection and analysis process

In terms of the qualitative approach, I collected data using three main methods that reflect the qualitative inquiry: documentary analyses, interviews and classroom observations.

These methods enabled me to answer the sub-questions 1, 2, and 3. In contrast, I used questionnaires as a method to collect data only from the Saudi context to assist to answer the fourth sub-question based on the Saudi study. Bray, Adamson and Mason (2007) explained that, in comparative education, different issues require specific and different methods, which means that the researcher has a wide variety of methods to choose from in order to answer a specific inquiry. I believe that this is a comparative study that requires methods that lead to reliable data and fair comparison, but I also believe that the one of the criteria for choosing the research methods is the nature of research questions. Accordingly, I used questionnaires to collect data from the Saudi context because the goal of the study, as mentioned in chapter 1 (research aims), is not merely to show the similarities and the differences, but also to introduce some suggestions to improve teaching technology education in the Saudi primary education. Therefore, involving more participants from the Saudi context will help produce rich data about participants' perceptions of this aspect. Hence, this was the appropriate method to reach those participants.

4.2.1.2 Documentary analysis

The first source was *documentary analysis*. Two formal documents were used in New Zealand as major documentary data: (1) the National Education Guidelines (NEGs), which reflect educational policy in New Zealand (Ministry of Education, 2008) and (2) Technology Education in the New Zealand Curriculum (Ministry of Education, 2007). In the Saudi context, two formal documents were also used as major documentary data: (1) the educational policy in the Kingdom of Saudi Arabia, and (2) primary science and technology textbooks. The purpose of analysing educational documents was to gain a better understanding of how technology education is interpreted and structured in the formal documents. The analysis helped the researcher explore these aspects related to technology education: What is technology education? What is the goal of teaching it? How is it constructed in the curriculum? How is it implemented in the classrooms? Initially, I preferred to analyse documents before using other data collection instruments, interviews and classroom observations, because I believe that this step is crucial for improving my knowledge of the content of those documents that could contribute to develop the other instruments and to facilitate the process of conducting this study.

4.2.1.3 Interviews

The second source was *interviews*. Punch (2005) stated, “The interview is one of the main data collection tools in qualitative research” (p. 168). Creswell (2003) found that a key advantage of this type of data collection is the way in which participants can provide historical information. Also, researchers have control over the line of questioning. Similarly, Punch (2005) believed that the interview is one of the most powerful ways to understand others. Fontana and Frey (1994) used a three-way classification of structured, semi-structured and unstructured interviews. In the present study, I used semi-structured interviews (face-to-face) for the reasons identified by Dawson (2002); that is, “In this type of interview, the researcher wants to know specific information which can be compared and contrasted with information gained in other interviews” (p. 29). In addition, Bishop (1997) explained that the advantage of using this type of interview is that the researcher is able to gain access to participants’ ideas, thoughts, and memories in their own words and to encourage free interaction and opportunities for clarification and discussion between the researcher and the interviewees by using open ended questions rather than close-ended questions.

The first step was to identify the purpose of the interview, which was to understand the perceptions of the participants of teaching technology education in Saudi primary education. The researcher could then identify the participants who would be involved in the study. Two technology teachers and two technology experts from New Zealand were interviewed, along with two science and technology teachers and two science and technology experts from Saudi Arabia. I selected this number of participants because interviews were not the only method used in this study. The study also used the mixed qualitative methods, supported by the quantitative method. Guest, Bunce and Johnson (2006) indicated that, when the mixed qualitative methods system is used, a small number of interviewees can strengthen the study.

The questions were developed to ask technology teachers and technology experts about their perceptions regarding the teaching of technology education. The participants were asked the same questions in both contexts. Before the interviews, I explained to the interviewees the purpose of the interview and their rights as participants by providing them

with the consent forms that included all relevant information; see Appendices 1, 2, 3 and 4). Also, Appendices 11 and 12 show the questions put to the teachers and the experts.

The data were analysed manually thorough open coding outlined in the next paragraph to identify the themes and categories that emerged from the interviews. Theme identification is one of the most important tasks in qualitative research. Opler (1945) explained that:

“In every culture ... are found a limited number of dynamic affirmations, called themes, which control behavior or stimulate activity. The activities, prohibitions of activities, or references which result from the acceptance of a theme are its expressions ... The expressions of a theme, of course, aid us in discovering it.” (pp. 198–99)

I used an analysis of words technique (keywords in context), as suggested by Ryan and Bernard (2003). This technique involves discovering themes in the interview transcripts and attempting to verify, confirm, and qualify them by searching through the data and repeating the process to identify further themes and categories. Once the interviews have been transcribed verbatim, the researcher reads each transcript and makes notes in the margins about words, theories or short phrases that sum up what is being said in the text. This is usually known as open coding (Punch, 2005). This technique was also used to generate the themes from the following open questions in the questionnaire.

4.2.1.4 Digital recording and photography

I used a digital recorder in the interviews, as recommended by some researchers. For example, “Recording has the advantage of capturing data more faithfully than hurriedly-written notes might, and can make it easier for the researcher to focus on the interview” (Hoepfi, 1997, p. 53). A digital camera was used in the classrooms to capture photos of the students and the teachers while they were working together. Turnbull (2013) indicated that photographs can provide excellent data for qualitative research because they can be used to help remember events at the time the photograph was taken.

4.2.1.5 Classroom observations

The third source of data was classroom *observation*. Observing how technology education was taught in the classrooms enabled me to have a better understanding of the context

within which technology education occurs. Hoepfi (1997) argued that “observation can lead to deeper understanding than interviews alone” (p. 53). During these observations, I took field notes and interacted with teachers and students during the actual lessons in technology education. All observation sessions were digitally recorded, which helped in the later analysis of the data.

4.2.1.6 Components of the observation sheet

An observation sheet was an important data collection method that helped me find answers to the research questions. Based on Tóth (2012), Sullivan, Mousley and Ann (2000), Ministry of Education (2007a), and Techlink (2010), as well as my own experience, I developed a classroom observation sheets, see (Appendix: 5A and 5C), that included the following four main components: *general information*, *learning environment*, *process of teaching and learning*, and *indicators of progression* (explained below) These components are important for observations of teaching in the classroom because they cover all the aspects that the researcher believes will help to observe how technology education is implemented in the classroom.

The first part of the observation sheet was *general information*, which included the session number, day, date, year, technology education area, topic, focus of learning of the unit, lesson objectives, and other comments.

The second part concerned the *learning environment*. The aim of this part was to observe the technology learning environment by observing the relevant factors that are important to deliver technology to students in a successful way. There were nine such factors: teacher efficacy and knowledge of teaching, classroom management, unit plan, type of pedagogy used, teacher’s interactions with students, students’ interaction with the teacher, students’ collaboration with peers, using thinking skills in learning, and adequacy of technology materials to meet lesson objectives.

The third part regarded the *process of teaching and learning*. By observing the process of teaching and learning in the classroom, my intention was to see how technology is taught ‘on the ground’; that is, how the teacher uses the components of a learning environment to help students design a specified product that effectively meets specified criteria or needs. I

observed the following eight elements: relation of materials used to lesson objectives, identifying lesson objectives, students' learning styles, students' prior knowledge consideration, students' cultural consideration, the use of technological terms, teaching authentic learning, and enhancing students' technological literacy. An example of each element will be provided in the when I explain what I observed in the classrooms under classrooms observation procedure section in Chapter 5.

Finally, the fourth part of the observation sheet concerned *Indicators of Progression* of teaching technology education: see Appendix 5B. The Ministry of Education (Techlink, 2010) set some indicators listed in matrices (see Table 4.1 as an example) to describe what actions are expected from students at each level and the roles are expected from the teachers to support students at all levels. There are eight levels of achievement objectives that students should achieve across their 13 years of general education. The indicators of progression also help teachers and students to develop a sense of how technology education fosters technological literacy and how it is processed through teaching. The indicators shown in the matrices provide a general understanding and capabilities that will be developed through working across a range of different levels and types of strands and components. Table 4.1 provides an example of indicators of progression in Levels 1 and 3 related to the Technological Practice Strand.

Table 4.1: Levels 1 and 3 of indicators of progression of technological practice strand.
Source: Techlink (2010).

Components of Technological Practice: Indicators of Progression (Level One)		
Teachers should establish whether students hold any misconceptions or partial understandings that would inhibit the students' meeting the Level 1 achievement objectives for the technological practice, and plan learning experiences to challenge and/or progress these as guided by the Level 1 indicators below.		
Brief development	Planning for Practice	outcome development & evaluation
Achievement objective Students will: Describe the outcome they are developing and identify the attributes it should have, taking	Achievement objective Students will: Outline a general plan to support the development of an outcome, identifying appropriate steps and resources.	Achievement objective Students will: Investigate a context to communicate potential outcomes. Evaluate these against attributes; select and develop an outcome in keeping with the identified attributes.

account of the need or opportunity and the resources available.		
<p>Teacher Guidance</p> <p>To support students to undertake brief development at Level 1, teachers could:</p> <ul style="list-style-type: none"> • Provide the need or opportunity and develop the conceptual statement in negotiation with the students. • Provide a range of attributes for discussion • Guide students to identify the attributes an appropriate outcome should have. 	<p>Teacher Guidance</p> <p>To support students to undertake planning for practice at Level 1, teachers could:</p> <ul style="list-style-type: none"> • Ensure that there is a brief against which planning to develop an outcome can occur. • Provide students with a detailed plan of what they will be doing during their technological practice. This could be presented and explained as a design process the teacher has developed, with the essential key stages clearly identified within it. • Provide a range of appropriate resources for students to choose from. <p>Teachers should ensure all resources provided are appropriate for use and students should only be responsible for selecting particular materials components, and/or software from these resources.</p>	<p>Teacher Guidance</p> <p>To support students to undertake outcome development and evaluation at Level 1, teachers could:</p> <ul style="list-style-type: none"> • Ensure that there is a brief with attributes against which a developed outcome can be evaluated. • Establish an environment that encourages and supports student innovation when generating design ideas. • Provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card, etc. • Provide opportunities to develop the skills required to produce their outcome.
<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Communicate the outcome to be produced. • Identify attributes for an outcome 	<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Identify what they will do next. • Identify the particular materials, components and/or software they might use. 	<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Describe potential outcomes, through drawing, models and/or verbally. • Identify potential outcomes that are in keeping with the attributes, and select one to produce. • Produce an outcome in keeping with identified attributes.
<p>Components of Technological Practice: Indicators of Progression Level 3</p>		
<p>Teachers should establish whether students have developed robust Level 3 competencies and are ready to begin working towards Level 3 achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the Level 3 indicators below.</p>		
Brief development	Planning for practice	Outcome development & evaluation
<p>Achievement objective</p> <p>Students will:</p> <ul style="list-style-type: none"> • Describe the nature of an intended outcome, explaining how it addresses the need or opportunity. Describe 	<p>Achievement objective</p> <p>Students will:</p> <p>Undertake planning to identify the key stages and resources required to develop an outcome.</p> <p>Revisit planning to include reviews of progress and identify implications for</p>	<p>Achievement objective</p> <p>Students will:</p> <ul style="list-style-type: none"> • Investigate a context to develop ideas for potential outcomes.

the key attributes that enable development and evaluation of an outcome.	subsequent decision making.	<ul style="list-style-type: none"> • Trial and evaluate these against key attributes to select and develop an outcome to address the need or opportunity. • Evaluate this outcome against the key attributes and how it addresses the need or opportunity.
<p>Teacher Guidance</p> <p>To support students to undertake brief development at Level 3, teachers could:</p> <ul style="list-style-type: none"> • Provide the need or opportunity and develop the conceptual statement in negotiation with the students. • Guide students to describe the physical and functional nature of an outcome (e.g., what it looks like and what it can do), taking into account the need or opportunity, conceptual statements and resources available. • Guide students to identify the key attributes an appropriate outcome should have. Key attributes reflect those that are deemed essential for the successful function of the outcome. 	<p>Teacher Guidance</p> <p>To support students to undertake planning for practice at Level 3, teachers could:</p> <ul style="list-style-type: none"> • Ensure that there is a brief against which planning to develop an outcome can occur. • Provide students with an overview of what they will need to do during their technological practice and guide students to identify key stages and place these on a timeline of some sort. • Provide resources, including a range of appropriate materials, components, software, hardware, equipment, and/or tools for students to select from and guide students to select those that will be suitable for their outcome. • Guide students to reflect on progress to make informed decisions regarding next steps. 	<p>Teacher Guidance</p> <p>To support students to undertake outcome development and evaluation at Level 3, teachers could:</p> <ul style="list-style-type: none"> • Ensure that there is a brief with attributes against which a developed outcome can be evaluated. • Establish an environment that encourages and supports student innovation when generating design ideas. • Provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card, etc. • Provide opportunities to develop knowledge and skills related to the performance properties of the materials/components students could use. • Support students to evaluate their outcome against the brief.
<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Describe the physical and functional nature of the outcome they are going to produce and explain how the outcome can address the need or opportunity. • Describe attributes for the outcome and identify those that are key for the development and evaluation of an outcome. 	<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Identify key stages, and resources required, and record when each stage will need to be completed in order to ensure an outcome is completed. • Explain progress to date in terms of meeting key stages and use of resources, and discuss implications for what they need to do next. 	<p>Indicators</p> <p>Students can:</p> <ul style="list-style-type: none"> • Describe design ideas (either through drawing, models and/or verbally) for potential outcomes. • Evaluate design ideas in terms of key attributes to develop a conceptual design for the outcome. • Select materials/components, based on their performance properties, for use in the production of the outcome. • Produce an outcome that addresses the brief. • Evaluate the final outcome against the key attributes in order to determine how well it met the need or opportunity.

Brief development, planning for practice, and outcome development and evaluation are components of the Technological Practice strand that shapes the concept of technology education with other strands, namely technological knowledge and the nature of technology. Thus, I included the elements of achievement objective, teacher guideline, and

indicators of each component in the observation sheet. This helped me observe the extent to which the teaching of technology education in the classroom reflects these components.

4.2.1.7 Classrooms observed

Year 2 and Year 6 classrooms were selected to be observed in a primary school in New Zealand (Christchurch), while classrooms in Years 5 and 6 were selected in a primary school in Saudi Arabia (Jeddah). Years 2 and 6 were selected in New Zealand because I wanted to observe teaching technology education in junior and senior classrooms. In the Saudi Arabia context, I was not able to select a junior classroom because the observation was conducted during the first semester of the year, during which science and technology is not taught for junior students.

4.2.1.8 Entering the field

Entering any school for research purposes requires a plan of action that must be prepared in order to facilitate the communication between the researcher and the school administration. Gaining access often requires a combination of strategic planning, hard work and luck (Van Maanen and Kolb, 1985). The first step is to obtain permission from the ‘gatekeepers’ who have the authority to control access to the site (Neuman, 2000). Once the schools had approved the access, the next step was to negotiate with the teachers about the project and the procedure of conducting the observation, and to provide all the relevant information, including research objectives, time and resources; these aspects were explained to the teachers in the meeting.

4.2.1.9 Questionnaire

In terms of quantitative inquiry, the aim of using this approach was in line with one of the overall goals of the study; that is, to understand the perceptions people have of science and technology education in primary schools in Saudi Arabia. Exploring their perceptions gave me a better understanding of this subject in the Saudi curriculum

4.2.1.10 Questionnaire design

To collect data quantitatively, I developed a questionnaire (see the full questionnaire in Appendixes 6, 7, and 8. This questionnaire was designed based on my own experience and

the literature review (Al-Ghamdi 2012; Al-Ghamdi & Al-Salouli 2013; Fath-Allah, 2006; Lebeaume 2011; Jones & Carr 1992; Gravemeijer & Baartman 2011; de Vries, 2012). I was not able to find any previous survey developed in the Arabic context that asked teachers and science and technology experts about teaching technology in public schools. Therefore, I constructed a measuring instrument, as suggested by Punch (2005), as follows.

1- Defining the instrument and what it measures

The questionnaire was the instrument used in this study to obtain factual and attitudinal information from the participants. Asner-Self and Schreiber (2011, p. 15) indicated that a questionnaire “is used to describe attitudes, buying habits, voting preferences, and other types of phenomenon or behaviour” by asking “a set of pre-formulated questions in a predetermined sequence ... to a sample of individuals drawn so as to be representative of a defined population.” Coleman and Briggs (2002, p. 93) argued that some experts in educational research consider questionnaires to be a unique methodology instead of solely a method of data collection (Wiersma, 2000). In the present study, the instrument was used to measure perceptions of the following groups about technology education in the Saudi primary curriculum:

- 1- Science teachers in the Almahd Region;
- 2- Technology tutors at technology colleges and the vocational institute in the cities of Makkah and Jeddah, and
- 3- Technology advisors in the Technology Council of the Makkah Region.

Like any instrument, a questionnaire has strengths and limitations. As explained by Manion and Morrison (2005), the strengths of a questionnaire are that it is:

- 1- Able to produce generalizable results;
- 2- Suitable for utilisation in descriptive and explanatory studies;
- 3- Able to provide greater anonymity to participants (which was helpful in the present study since the questionnaire dealt with aspects related to perceptions and attitudes), and

- 4- A stable, consistent, and uniform measure without variation.

The limitations of questionnaires are:

- 1- Ambiguity and misunderstanding of questions could not be detected and clarified at the time;
- 2- Participants might not have reported their true perceptions and feelings, in order to present themselves in a good light, and
- 3- The questionnaire design and layout has to be attractive, with a minimal number of pages, and the need to achieve this can the questionnaire's content and the questions asked in terms of quantity and quality.

2- Selecting the measuring technique

The Likert response format (known as the Likert Scale) was used in this study. This rating scale was introduced in 1932 by the social psychologist Rensis Likert (Sullivan, 2009). A Likert scale invites individuals to rate their level of agreement or disagreement with items measuring their attitudes or perceptions. While traditional Likert-type items have five-point rating scales, the number of points may vary. Items in a Likert scale measure the same construct and are summed to produce an overall scale score. Likert scaling, or the use of multiple items, is important because single-item measures of constructs are notoriously unreliable.

3- Generating items

As mentioned above, this instrument was used to measure perceptions of science teachers, technology tutors and technology advisors about technology education in the Saudi primary curriculum. Consequently, three types of questionnaires were designed specifically for each cohort and each questionnaire contained (closed-questions) and open questions. There were 24 statements in the science teachers' questionnaire, 15 statements in the version for tutors at technology colleges and the vocational institute, and 15 statements in the questionnaire for advisors in the Technology Council, Makkah Region. Three open questions were also included in the questionnaires in order to give the respondents flexibility to answer some key questions in any way they wished. The purpose

of closed questions was to generally understand the participants' perceptions of the situation of science and technology in the primary education in Saudi Arabia, while the purpose of open questions was to understand the suggestions that the participants gave to improve teaching technology education in Saudi Arabia. These kinds of questions must give respondents flexibility to answer in any way they wish in order to obtain true opinions/attitudes about this topic. The questions were kept short and clear instructions were given on the first page of the questionnaire to inform the participants of the topic and the purpose of the questionnaire. The questionnaire was written in English and the final version was then translated into Arabic because the study participants were Arabic native speakers. In the case of open-ended questions, sufficient space was left for detailed responses.

4- Piloting and implementation

The questionnaires were sent to two science teachers, two tutors, and two technology experts to ensure the quality of the content and English/Arabic translation. They usefully contributed feedback that enabled the researcher to produce a final version of the questionnaire. Corrections included typographical errors, clarification of wording, deletion of some overlapping questions, and changes in the sequence and content of some questions. Examples included adding suitable verbs at the beginning of some statements to make them more simple and understandable. Another suggestion was to move questions 17 and 18 on the science teachers' questionnaires to the open-questions section. Having completed the pilot phase, the full implementation phase followed. The researcher made arrangements with a research liaison officer at each institution to distribute the questionnaires to the participants (Table 4-2 below shows details of the participants); email was the means of communication between the researcher and the participants from the time the questionnaires were sent until they were returned.

4.2.1.11 Questionnaire returns

Of the 110 questionnaires distributed, 82 were returned completed (a response rate of 90.2 percent, which is considered very good. The response rate of each sample was over 84 percent, except the response rate of science teachers, which was 55 percent. I did take some steps to maximize this response rate by designing clear and simple questionnaires

that were easy to answer and seen as relevant by respondents. Also, the instructions were clear and all important terms were clearly defined. Table 4-2 below shows the response rate.

Table 4.2: Response Rates

Sample	Invited	Responded	Percentage
Science Teachers	40	22	55
Tutors	45	38	84.4
Technology Advisors	25	22	88
Total	110	82	74.5

4.3 Sampling

This study investigates technology in one of the contributing primary schools in New Zealand. This kind of school offers education from Years 1–6 (students between the ages of 5 and 10). The study also investigates science and technology education as taught in Saudi primary schools, in which there is only one type of primary education (Years 1–6, or students between the ages of 6 and 11). The initial phase of the investigation – document analysis, an interview and classroom observation – facilitated the qualitative analysis of two groups of respondents in New Zealand and two groups of respondents in Saudi Arabia. The second phase was a cross-sectional survey to collect the quantitative data in order to provide a snapshot of that population at that point in time. Thus, three types of questionnaires were sent to three groups of respondents in Saudi Arabia. Tables 4.3 and 4.4 below present more details of the population in this study.

Table 4.3: Sample of New Zealand and Saudi contexts (qualitative phase).

Number of participants involved in the first study in NZ		Number of participants involved in the second study in Saudi Arabia		Total
Technology Teachers	Technology Experts	Science and Technology Teachers	Science and Technology Experts	4 Groups of Respondents
2	2	2	2	8

Table 4.4: Sample of the Saudi context (quantitative data).

Participants	Location of data source	Number of participants
Science Teachers	Primary schools in Almahd Province	22
Tutors	Technical and vocational institute in Jeddah	17
	Technology college in Makkah	10
	Technology college in Jeddah	11
Technology Advisors	Technology Council of Makkah Region	22
Total		82

4.3.1 Sample selection process

This study investigated the implementation of technology education in primary schools in New Zealand and Saudi schools and sought to understand participants' perceptions of this subject in both contexts.

The non-probability sample was implemented in order to collect qualitative data and quantitative data through interviews, classroom observations and questionnaires. This kind of sample implies that some participants in the population are more likely to be selected than others (Bryman, 2001). Two types of non-probabilistic methods were used in this study. *Convenience sampling* is used when the researcher has access to the sample and can approach the sample easily, and *purposive sampling* is selected in a deliberate way, "with some purpose or focus in mind" (Punch, 2005, p. 187). The convenience sampling involved the interviewed participants and the purposive sampling involved the two schools (one in New Zealand and one in Saudi Arabia) that I selected to observe technology in classrooms. I only chose one school from each context because I used a case study strategy to investigate this issue by collecting data from different resources: documentary analysis, interviews, survey, and classroom observation. This range of data from different sources should provide the thesis with the information needed to propose answers to the research questions. Selecting one school from each context for the observational and interview data

leads to problems in generalizing conclusions. On the other hand, including more schools would have led to a substantially greater research work, which may not fit the time frame that has been allocated to finish this study.

I deliberately chose a school that offered a good practice of teaching these subjects. In New Zealand, one of my supervisors, who has experience in technology education, helped me choose this school. In the Saudi context, I was guided by one of the experts in science and technology to select the school that was part of this study. In such types of sample, the researcher's experience helps him or her select samples that are representative or typical (Coleman & Briggs, 2002). In addition, purposive sampling was used to collect quantitative data from the Saudi context through questionnaires that were distributed to science teachers in the Educational Directorate in the Almahd governorate.

4.4 Data Analysis Procedures

The data analysis stage is a very important part of the research, since it changes the raw data obtained from the data collection tools into meaningful information. Bogdan and Biklen (1982) defined data analysis as “working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others” (p. 145). The following sections summarise the data analysis process for the data collection methods used in this study. The first section represents qualitative data analysis, which includes documentary analysis, interviews, classroom observations and open-ended questions from the questionnaires. The second section represents quantitative data analysis (questionnaires).

4.4.1 First phase of data analysis: Qualitative data

The qualitative data was initially analysed through the following processes suggested by Creswell (2002).

- 1- *Preparing and organising the data for analysis.* I started organising the data by developing a table of sources that could be used to organise the information. Cheong and Ming (1995) emphasised, “Organisation of data is critical in qualitative research because of the large amount of information gathered during a study” (p. 259). All material, including interviews, observations, and documents,

was organised by type; for example, by participants and locations. This was followed by transcribing the recorded data into text data.

- 2- Exploring the data. After transcribing the data, I started to analyse it by reading through all the data in order to gain a general sense of it, and then by classifying ideas.
- 3- Describing and developing themes from the data. This stage was significant because it helped to obtain information that was necessary to answer the research questions. To do this, the following procedures were used.
 - Coding text
 - Developing a description from the data
 - Defining themes from the data
 - Connecting and interrelating themes.
- 4- Representing and reporting the findings. At this stage, all obtained data was ready to be constructed, reported, and displayed in a systematic and logical way.
- 5- Interpreting the findings. This stage is also called abstracting and comparing (Punch, 2005, p.202). Here, I started to interpret all data by referring them to the literature and comparing the findings from New Zealand with those from Saudi Arabia.
- 6- Validating the accuracy and credibility of the findings. In social research, it is important to address psychometric characteristics of an instrument (validity and reliability). Doing so helps researchers to assess either the measuring instrument that they have obtained from the literature or the measuring instrument that they have developed (Punch, 2005).

4.4.2 Second phase of data analysis: Quantitative data

All data was converted into electronic form using a Microsoft Excel spread sheet. Picciano (2004, p. 30) indicated that this software is useful “for simple descriptive analysis such as frequency distributions and means.” Thus, the data was converted into spread sheet format and the findings were displayed as tables. The data was then ready to be analysed and each

of the four questionnaires was analysed separately by reducing data into several categories (Mutch, 2005), although all the results were discussed together in the discussion section (which follows the results analysis section).

4.4-3 Reliability and validity

In this study, issues related to reliability and validity were thoroughly considered. When considering reliability in research, researchers need to ask to what extent the results of their research are consistent over time and an accurate representation of the total population. If they get the same results under a similar methodology, then the research is considered to be reliable, while validity determines whether the research truly measures the phenomenon that the researcher wants to investigate (Golafshani, 2003).

4.4.3.1 Interviews

In this study, different techniques were used to ensure the reliability of the data gathered by interviews, including asking the same questions in the same order for the participants involved in this study. The reliability was also maintained by pre-testing the interview to ensure that all participants would understand the questions similarly to avoid any kind of uncertainty or ambiguity. I interviewed two science teachers and two technology experts, whose feedback contributed to strengthen reliability and validity of the interview as a data collection method. The data were also transcribed and returned to the participants for checking.

4.4.3.2 Questionnaires

Testing a questionnaire's reliability assesses the internal consistency of items' "latent traits" to help us to infer the extent to which the items are consistent with each other (Punch, 2005). Thus, to ensure the reliability of questionnaire's content, the questionnaire's content reliability and validity were confirmed as follows.

- 1- As mentioned in the questionnaire design section, the questionnaires were sent to five science teachers, five technology tutors and five technology advisors to review and ensure that their content was suitable for this study.

- 2- A second draft of the questionnaire was sent to two Saudi education academics who have good spoken and written skills in both Arabic and English. They provided useful comments for enhancing the questionnaires' effectiveness.

4.5 Ethical Considerations

In this study, I considered the following ethical issues.

Informed and voluntary consent

Participants were provided with an information consent form that was presented in clear and simple language. Participants were informed about the following:

- The names of the researcher and supervisor
- The procedures to be used
- The aim of this research and how the information would be used; for example, whether this research would be published
- The participant's right to withdraw from the process without penalty before the data collection process was completed
- The fact that the data would be returned to them to provide feedback
- What would happen to the information, and whether it would be aggregated with other information
- The fact that the information would be transcribed by another person and this person would be required to sign a confidentiality agreement
- What would happen to the data after completing the research
- The possibility of seeing the final report and, if so, how this process would be conducted.

Respect for rights of privacy and confidentiality

In an effort to respect privacy and confidentiality, I protected the identity of participants and their schools at all stages of the research. For example, I did not disclose the name of any participant when interviewing another, or otherwise provide information that could lead to a participant's identity being discovered. I was also responsible for keeping information (including the identity of participants) confidential and secure from

interception or appropriation by unauthorised persons, or for any purposes other than the approved research.

Minimisation of risk

I did not expose participants to unacceptable levels of social, physical or psychological risk or harm (including stress, emotional distress, fatigue, embarrassment and cultural dissonance). All participants were happy to be involved in this study and I did not notice any discomfort amongst them.

4.6 Consistency and Comprehensiveness of the Study

I endeavoured to ensure the consistency and the comprehensiveness of the study by carefully linking purpose of the study, its aims, and research questions to a suitable research design and methods that would help fulfil the aims, address the objectives, and answer the questions. I used the diagram suggested by Oyaid (2009) to represent the linking between elements of the current study.

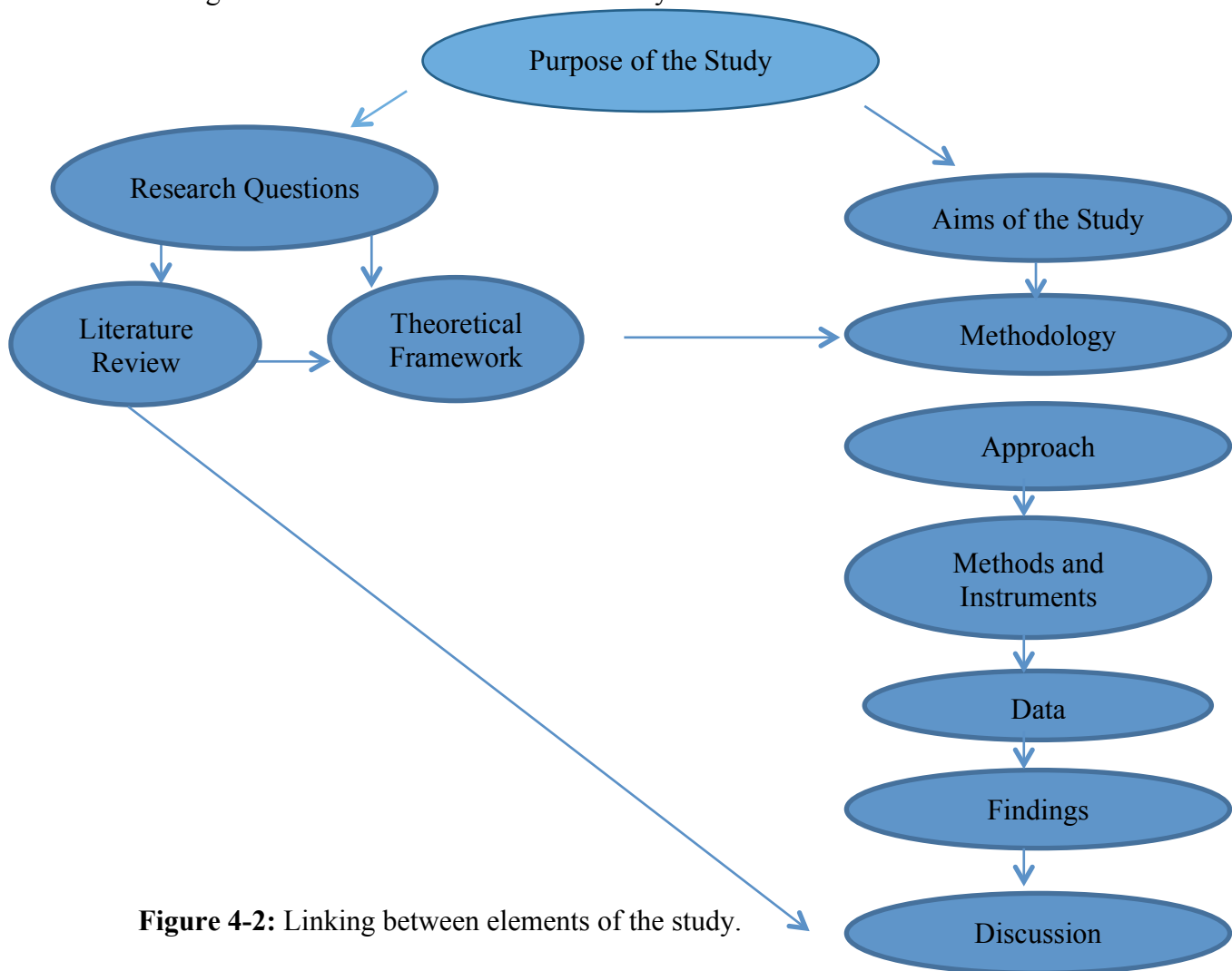


Figure 4-2: Linking between elements of the study.

4.7 Summary

This chapter has presented an account of the methodology and design of the research used in the present study. It has also presented a detailed account of how the empirical work was carried out, including a research paradigm and approach, research methods (design, strategy, questions, sampling, sample selection process, data collection and data analysis) and discussed ethical considerations. Chapter 5 includes the research results and starts to analyse the data derived from documentary analysis, interviews, classroom observation in both

contexts New Zealand and Saudi Arabia. It also presents the findings derived from the data generated by the questionnaire from the Saudi context.

Chapter 5

Findings of Two Studies Conducted in New Zealand and Saudi Arabia

5.0 Introduction

This chapter presents the findings of the study conducted in New Zealand and Saudi Arabia. The findings are presented in two phases under separate headings. Phase 1 includes qualitative data findings, while Phase 2 includes both qualitative and quantitative data findings. The results are integrated in the next chapter.

5.1 Phase 1: Findings of Study 1 in New Zealand

5.1.1 Documentary analysis findings

It is important to investigate the historical and structural development of technology education in New Zealand in order to understand the entire notion, including the formulation and implementation of this subject in New Zealand primary schools. Therefore, I have sought to analyse documents that are pertinent to that investigation. Punch (2005) asserted that “Documents, both historical and contemporary, are a rich source of data for social research” (p.184). She went on to argue that documentary sources of data should be used and collected in combination with interviews and observations. In the present study, two formal documents were used and analysed as major documentary data: (1) National Education Guidelines (NEG) (Ministry of Education, 2009f), which reflects educational policy in New Zealand; and (2) Technology Education in *The New Zealand Curriculum* (Ministry of Education, 2007a).

5.1.2 Identifying used documents and terms

Some basic information about the above documents will enable the reader to understand the kinds of documentary resources being discussed and analysed in relation to technology education in New Zealand. I also wish to avoid any confusion in definitions.

The first document is the National Education Guidelines (NEG), which provides general guidelines for educational policy in New Zealand. The guidelines has the five components outlined below.

5.1.2.1 National Education Goals (NEGS):

The Government sets the following goals for the education system of New Zealand.

- I. The highest standards of achievement, through programmes that enable all students to realise their full potential as individuals, and to develop the values needed to become full members of New Zealand's society.
- II. Equality of educational opportunity for all New Zealanders, by identifying and removing barriers to achievement.
- III. Development of the knowledge, understanding and skills that New Zealanders need to compete successfully in the modern, ever-changing world.
- IV. A sound foundation in the early years for future learning and achievement through programmes that include support for parents in their vital role as their children's first teachers.
- V. A broad education through a balanced curriculum covering essential learning areas. Priority should be given to the development of high levels of competence (knowledge and skills) in literacy and numeracy, science and technology and physical activity.
- VI. Excellence achieved through the establishment of clear learning objectives, monitoring student performance against those objectives, and programmes to meet individual needs.
- VII. Success in their learning for those with special needs by ensuring that they are identified and receive appropriate support.
- VIII. Access for students to a nationally and internationally recognised qualifications system to encourage a high level of participation in post-school education in New Zealand.
- IX. Increased participation and success by Māori through the advancement of Māori education initiatives, including education in Te Reo Māori, consistent with the principles of the Treaty of Waitangi.
- X. Respect for the diverse ethnic and cultural heritage of New Zealand people, with acknowledgment of the unique place of Māori, and New Zealand's role in the Pacific and as a member of the international community of nations.

5.1.2.2 Foundation curriculum policy statements.

These are statements of policy concerning teaching, learning and assessment that are made for the purposes of underpinning and giving direction to:

- I. The way in which curriculum and assessment responsibilities are to be managed in schools; and
- II. National curriculum statements and locally developed curricula.

5.1.2.3 National curriculum statements. These are statements of:

- I. The areas of knowledge and understanding to be covered by students;
- II. The skills to be developed by students; and
- III. Desirable levels of knowledge, understanding and skill to be achieved by students during the years of schooling.

5.1.2.4 National standards

These are standards regarding matters such as literacy and numeracy, which are applicable to all students of a particular age or in a particular year of schooling.

5.1.2.5 National Administration Guidelines (NAGs).

These guidelines relate to school administration and may include the following (without limitation):

- I. Statements of desirable codes or principles of conduct or administration for specified kinds or descriptions of person or body, including guidelines for the purposes of section 61 of the Education Act;
- II. Requirements relating to planning and reporting
- III. Communication of the Government's policy objectives; and
- IV. Transitional provisions for the purposes of national administration guidelines.

The above clearly shows that teaching technology is one of the national goals of education in New Zealand. As stated in Component 1 (V), priority should be given to the

development of high levels of competence (knowledge and skills) in science and technology with other essential learning areas. All of these learning aspects were taken into account when the Ministry launched The New Zealand Curriculum (Ministry of Education, 2007a), which includes Foundation Curriculum Policy Statements for each learning area. That document also identifies technology education as one of eight major learning areas. The Ministry of Education regards this document as:

A clear statement of what we deem important in education. It takes as its starting point a vision of our young people as lifelong learners who are confident and creative, connected and actively involved. It includes a clear set of principles on which to base curriculum decision making. It sets out values that are to be encouraged, modelled, and explored. It defines five key competencies that are critical to sustained learning and effective participation in society and that underline the emphasis on lifelong learning. (Ministry of Education, 2007a; p. 4)

5.2 Technology education in the New Zealand curriculum

For the present study, the educational policy and the Technology Education Curriculum were important sources of evidence of how technology education is interpreted in the New Zealand, and the way they are presented for teachers. It was clear from the educational policy that the Ministry of Education manages an education system based on education strategy. This strategy is defined in the NEG, which was developed and released in 2007 as a foundation for building the national curriculum. This national document stated that there are eight main learning areas, including technology. The Curriculum document also indicates that information communication technology (ICT) is a major area in technology education, along with other areas such as structural, control, food and biotechnology.

Technology was defined in the Curriculum (2007a) as follows:

Technology is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative... Technology is never static. It is influenced by and in turn impacts on the cultural, ethical, environmental, political, and economic conditions of the day. (p. 32)

This concept has an influence on reshaping the structure of technology, which currently comprises the three strands described in Chapter 3 of this thesis (the literature review).

- 1- Technological Practice: Through this strand, students can develop a range of outcomes based on a written plan that includes the three major aspects in designing the desired product. These are the components of technological practice: *brief development, planning for practice, and outcome development and evaluation*.
- 2- Technological Knowledge: This strand helps students to understand how and why things work. It consists of three components: *technological modelling, technological products, and technological systems*.
- 3- Nature of Technology: This strand shapes the theoretical dimension of technology education and aims to help students to distinguish the subject from other disciplines (Almutairi, 2009). There are two components of this strand: characteristics of technology and characteristics of technological outcomes.

As is the case with other subjects, the teaching of technology in New Zealand primary schools has been defined by the National Curriculum, which provides a framework as a shared direction for learning areas. Specifically, the technology framework defines technology, provides the aims of teaching technology, the structure of the learning area, and the achievement objectives of technology. The National Curriculum also allows schools to independently choose the technology curriculum that matches their students' needs, based on the school's circumstances. Similarly, it emphasises that all New Zealand students should experience technology that reflects a rich and balanced education and complies with the goals of the National Curriculum. Furthermore, the National Curriculum has taken into account the point that *values* and *key competences* are the basis for teaching and learning in New Zealand schools.

Values are described in the Ministry of Education (2007a) as “deeply held beliefs about what is important or desirable” (p. 10) and the curriculum asserts that each school should develop a set of values that are derived from its philosophy. However, the New Zealand Curriculum (2007) identified a number of values that could be used as a guide to support schools when they start developing their values:

- Excellence, by aiming high and persevering in the face of difficulties;
- Innovation, inquiry, and curiosity, by thinking critically, creatively, and reflectively;
- Diversity, as found in New Zealand's different cultures, languages and heritages;
- Equity, through fairness and social justice;
- Community and participation for the common good;
- Ecological sustainability, which includes care for the environment;
- Integrity; and
- Respect for themselves for others, and for human rights (p. 10).

Technology education, like other learning areas in the New Zealand curriculum, has eight levels of achievements. These levels typically relate to the number of years at school. Table 5.1 explains these levels.

Table 5.1: Years and curriculum levels of New Zealand education

New Zealand Curriculum levels	Achieved at year levels
Level 1	Years 1-2
Level 2	Years 2-5
Level 3	Years 4-7
Level 4	Years 6-9
Level 5	Years 9-10
Level 6	Years 10-12
Level 7	Years 11-13
Level 8	Years 13

5.3 Classroom Observations and Findings

5.3.1 Preparation for classroom observation

The general aim of the observations in this study was to observe and gain a better understanding of how technology education is taught in primary schools in New Zealand by attending classes that are considered to be good examples of teaching technology. This sampling is referred to in social research as “purposive sampling” (Punch, 2005, p. 187). Also, using a classroom observation strategy was an appropriate strategy for collecting data that helped me to answer the first sub-question of the study. That question was: How is technology education implemented in the New Zealand primary curriculum?

5.3.2 Year 2 Classroom observation

This observation took place in a Year 2 classroom that had 21 students. The topic was about making a gecko enclosure and the focus was on structural area (Level 1).

I set out what was observed in the classroom according to the following aspects: (1) General information about the class observed; (2) the learning environment (nine components) ; (3) the process of teaching and learning (eight components); and (4) Indicators of the progression of teaching technology; see Appendices 5A and 5B.

5.3.3 First session

The purpose of the first session was to introduce the unit to the students by involving them in the discussion. The unit was about making a “gecko enclosure.” Below, I explain what I observed in each session according to the observation aspects included in the observation sheet.

5.3.3.1 Aspect 1: General information about the observed class

Before I started observing the class, I sat with the teacher to collect some general information about the classroom, such as the session date, time, technology education area, topic, and focus of learning the unit. The topic was making a gecko enclosure, which represents the technological practice strand (brief development component), which was the focus of learning of the unit. Teaching this topic was associated with the ‘structural’ area of technology education.

5.3.3.2 Aspect 2: The learning environment

Nine components were used to evaluate the learning environment. The learning environment in the classroom is a combination of social and physical components that are important for evaluating the learning environment in a classroom. Outcomes of the observation related to this aspect indicate that the class in this particular session was a suitable example of a good classroom environment. The nine components are described below as they applied to the observed classroom:

1- Teacher efficacy and knowledge of teaching

The teacher (referred to herein as Jude, which is not her real name) has a bachelor's degree in teaching and learning and has seven years of experience teaching primary students.

2- Unit plan

Jude prepared a 'technology unit plan' to teach this topic. She identified several aspects that were crucial for teaching this topic, including achievement objectives, learning outcomes, teaching and learning sequence, resources, and assessment.

3- Classroom management

In this session, Jude was able to manage the classroom in a way that contributed to a suitable classroom atmosphere. She encouraged students to be involved in the discussion so that all students felt included, valued and respected. All students sat on the floor and the teacher sat on a chair in front of them. She looked at every child in the class to ensure that they were all engaged in the discussion. Keeping students regularly engaged and conscious of what is being done in the classroom is one of the positive aspects of non-verbal communication.

4- Type of pedagogy used

Jude used a variety of pedagogical methods to enrich students learning through using problem-based learning, enquiry learning and discussion. For example, she showed students a photo of the gecko, discussed what the topic was, and encouraged students to think individually about ideas for building a house for the gecko. Jude also told the students that it was okay for them to share their ideas with their peers and they could ask

their parents or friends outside the class to find further ideas or to discuss their own ideas with them.

5- Teacher's interactions with students

There was positive interaction between the teacher and her pupils, which encouraged them to be interactive and positively involved in the discussion. Jude introduced the topic in an effective way that pulled her students deeper into the topic. She started by telling them a story of a small animal who needed help to build a house in order to stay alive. Jude showed them some pictures of this animal – the gecko – and she started a discussion about it, including its environment and what type of food it eats.

6- Students' interaction with the teacher

The main question – “Why do we need to build a house for the gecko?” – elicited significant enthusiasm among the students. They provided several meaningful answers, such as to protect him, to keep him alive, and to protect the environment.

7- Students' collaboration with peers

In this session I did not notice any collaboration between students because the discussion was focused between the teacher and pupils and aimed to introduce the topic.

8- Using thinking skills in learning

Jude provided the pupils with opportunities to help them to use thinking skills in learning. For example, when the students provided an answer or idea, Jude asked them, “Why do you think this idea is useful?” One student said the gecko's house should include three windows and Jude asked why those three windows were important. The student answered that these windows would allow enough air to come into the house for the gecko to breathe easily. This demonstrates that the student was engaged in the discussion and showed a good level of thinking to discuss the suitable model of the house by justifying the suggested model.

9- Adequacy of technology materials to meet lesson objectives

Finally, the materials necessary to teach this topic were available, including posters and photos of the gecko, a mock-up of the gecko, coloured paper, cartons, scissors, a craft knife, a light bulb, glue and a hot glue gun.

5.3.3.3 Aspect Three: Process of teaching and learning

The following eight components were used to evaluate process of teaching and learning.

1- Relation of materials to lesson objectives

The teacher discussed with the students what materials they would need to design and build the gecko house. The students were able to identify some of these materials, such as wood, a knife, and carton. The teacher helped them to identify other materials such as a hot glue gun, light bulbs, and coloured paper. I noticed that these materials were available in the classroom and were used to achieve the main objective of designing the gecko house.

2- Identifying lesson objectives

The teacher clearly explained the objective of the lesson by discussing such questions as “What will you do?” “Why will you do it?” and “How will you do it?” These questions helped students to understand the objective of the unit as designing a house for the gecko to protect it by using available materials.

3- Students’ learning style

Discussions and individual learning were the dominant learning styles observed in this session. These learning styles are important to assist the teacher to introduce the topic to the students before commencing the practical activities that need different learning styles. The teacher used discussion and individual learning methods to discuss with the students the general themes and ideas of the topic that will be delivered in the class and she asked the students to individually think about the resources that they need to design the product.

4- Students’ prior knowledge

Understanding students’ prior knowledge of the topic is a good strategy when introducing the topic. Hence, the teacher started the lesson by asking the student, “Where have you

seen this animal? What is its name? What more do you know about it? Have you seen it before outside school?”

5- Students’ cultural consideration

The teacher did not take any action to consider this aspect in this session.

6- Using technical terms in the classroom

By taking note of this component, I wanted to understand the influence of teaching technology education on students to use technical terms that reflect the impact of technology education on students’ technological literacy. There were some technical terms used in this session, such as design, model, properties of materials, and problem solving and

7- Engaging students in an authentic task

In this session, the students were engaged in authentic learning by encouraging them to practice a task that was relevant to their culture and life. I found that teaching this topic was relevant to students’ culture and life because geckos are commonly found in New Zealand. This topic was a good example of providing students with an authentic learning. They saw the gecko and they participated in setting the goal of the lesson and they were involved in choosing the materials that would help them solve the problem that the gecko would face; that is, building a home.

8- Enhancing students’ technological literacy

Finally, through this component I wanted to observe the influence of technology education on students’ technological literacy as a general goal of technology education in the New Zealand curriculum. The content of this topic reflected this goal by engaging students in a task that helped them to enhance students’ technological literacy (technological practice), while technological knowledge, and nature of technology were not implemented in the classroom and this indicates that the teacher had a narrow view of implementing technology education. This lesson helped students to understand how they think about a particular problem, how they choose good resources to solve the problem, how to test these resources, and how to evaluate the final model. All of these factors are important

aspects of teaching technology education in order to develop students' technological literacy.

5.3.3.4 Aspect 4: Indicators of progression of technology areas

As mentioned in Aspect 2, the focus of this unit was on the Technological Practice strand (Level 1) according to the New Zealand Curriculum (2007a). The indicators of progression help the teacher to describe the expected achievement objectives as a result of students' learning in each component of the technological area, and these indicators also highlight the roles of the teacher to support students in each component at all levels.

Technology indicators of progression level one (Table 4.1) were used to explore in depth the extent to which the process of learning reflected these indicators by observing how the teacher guided her students to learn and also by observing what the students achieved. She focused only on the *technological practice* strand because she did not believe the two other strands were necessary at this stage.

The component for *brief development* was the first step in the learning process. It was designed by the teacher who provided the opportunity and developed the conceptual statement in negotiation with students. This was clearly observed when she showed the problem to the students by saying, "Our problem today is about a gecko. It needs a home and you will be asked to design and to build a suitable one for it." The teacher was aiming to develop a conceptual statement and provide students with the opportunity to negotiate this design with her. For example, the teacher asked students to "design a suitable home for the gecko," adding that "this home must have a place for the gecko to hide." She asked students, "Why do you think we are making gecko houses?" Some answers were, "to save it," and "so geckos can live longer."

Moreover, Jude guided her students to identify the attributes and an appropriate outcome; that is, the gecko's house. She helped students to do that by asking, "What information do you know and what information do you need to build a house?" This encouraged students to talk about the gecko's house, and they collaboratively identified its attributes during the introductory session. For example, they told Jude that they need to know, how big the gecko is, what type of gecko it is, and what type of food it eats. They also named some

required items, including “camouflage”, “materials”, “windows”, and “light”. Additionally, students were able to give reasons for using these materials. For example, they said, “We use the light to keep the gecko warm,” and “The windows allow the sunshine to enter the house.” Jude also encouraged students to think about the most appropriate attributes of the product by answering the following question: “If the gecko is coming up and pushes with his head, what do you need to do to stop him from getting out?” One student suggested covering the enclosure with a piece of plastic. Jude then asked, “Then how can we bring the water and the food in?” Another student said, “By leaving one side open,” to which Jude responded that the gecko might escape. A third student suggested, “Make a lock.” Jude agreed with this option and said, “Make a latch that is a spring lock, similar to the door.” From this discussion, I noticed that students were able to communicate the outcome of designing an enclosure for the gecko and they also identified suitable attributes for the outcome. I also noticed that the indicators of progression, in the first session, were directed to *brief development component* while the teacher focused on *planning for practice component* in the second session.

5.3.4 Second session

5.3.4.1 Aspect 2: The learning environment

After the teacher had explained the topic to the students and identified its objectives, she started to involve students in the practical task of designing a house for the gecko. In this session, I focused on components 4, 5, 6, 7 and 8 because the other components were general data of the unit and the learning environment in the classroom, which were applied in the other sessions.

4- Type of pedagogy used

In Session 2 the teacher used a variety of pedagogical methods to enrich students’ learning through using problem-based learning, enquiry learning and discussion.

5- Teacher’s interactions with students

I noticed in this session that the teacher interacted with the students by telling them how they could sit together to discuss their ideas about how to build the house. Jude encouraged the students to use the facts they had identified to design the gecko’s house and she

provided them with a detailed plan of what they would be doing to make that design. She gave them instructions for making the enclosure, starting by discussing the materials they would use. For example, she showed them a craft knife and asked them, “What is this and what are you going to use it for?” She also showed them the scissors and asked them what they would use them for, and asked, “Why do we use both tools together?” After listening to their answers, Jude told them that this is what you should think of in technology education when you use materials: “You should know the materials and why you use them to make any design.” Also, the teacher showed her students some models and pictures of the gecko and explained that at the end of the project they will need to put these geckos into the models that they are going to make.

6- Students’ interaction with the teacher

There was obvious interaction between the students and their teacher. The students showed the teachers the ideas that they had for building the house and they asked her to suggest other ideas and to evaluate their ideas.

7- Students’ collaboration with peers

In this session, the students were able to collaborate with each other because the teacher asked them to sit together and ask each other about their ideas for designing the house. This helped the students compare their designs with those of others. Thus, I noticed remarkable collaboration between students themselves that helped them to talk about their designs.

8- Using thinking skills in learning

The teacher gave students the opportunity to think carefully about their design by saying, “Now I am going to give you your sheet and you are going to start to give some drawings of your gecko enclosure. When you are drawing the picture, I would like you to think about what the outside is going to look like. What is the inside going to look like? What might the colour be? What might the shape be?” I observed that students worked through the design process using a scaffolded plan that included the steps and the resources used. For instance, each student was given a piece of paper to draw the design he/she liked and to name its parts. While they were working on the design, I asked some students about the

parts of the design and the materials they could use. They explained, for example, “We need a light bulb to make the house warm.”

5.3.4.2 Aspect three: The process of teaching and learning

In this session, the focus was on the *planning for practice* component. In the previous session, the students identified the steps and resources that they need to build the model. In session 2, they outlined a general plan to support the development of an outcome by drawing the model on the sheet that will be used as a blueprint to make the model. Eight components were used to evaluate process of teaching and learning.

1- Relation of materials to lesson objectives

The students used A3-sized paper sheets, pencils, and colouring pencils to draw the design of the house. These materials were relative to this session’s objectives, which aimed to draw the design and to evaluate it.

2- Identifying lesson objectives

The teacher discussed the objectives of the session with the students. She told them there are two objectives: to transfer their ideas onto a paper sheet using the available resources, and to evaluate the drawn design with their peers.

3- Students’ learning style

In this session, the collaborative learning was obvious when the teacher asked students to sit together and work collaboratively to discuss their ideas. In addition, the teacher encouraged students to draw the design individually that reflects the individual learning style. I noticed that each student was drawing the design individually. Some of them asked the teacher to help them but the teacher advised them to complete the design first and said they can evaluate it together when all the students had finished. The teacher wanted to push students to learn individually in order to improve their thinking skills and to give them the chance to express their ideas without any external influence.

4- Students’ prior knowledge

The teacher discussed with the students the materials that they identified in session 1 to explore the knowledge that they learnt from that session and to ensure that the students

have become aware of the materials used to design the house and the right way to use these materials. For example, she asked them what materials they had identified to make the model. She asked them to mention only one new material each. The students were able to name materials that had already been mentioned.

5- Students' cultural consideration

The teacher did not take any action to consider this aspect in this session.

6- Using technological terms in the classroom

The students used the same technological terms that they used in session 1, such as design, model, properties of materials, problem solving. Some students used other terms, such as project and design evaluation, in this session (session 2).

7- Engaging students in authentic task

As mentioned in session 1, the students were engaged in authentic learning by encouraging them to practice a task that was relevant to their culture and life. I noticed that teaching this topic was relevant to students' culture and life because geckos are commonly found in New Zealand. This topic was a good example of providing students with authentic learning. The students saw the gecko and participated in setting the goal of the lesson and were involved in choosing the materials that would help them solve the problem that the gecko would face; that is, building a home.

8- Enhancing students' technological literacy

The activity that the students were involved in helped them enhance their technological literacy (technological practice). I noticed that this lesson helped students to outline a general plan to support the development of an outcome by drawing the model on the sheet that will be used as a blueprint to make the model.

5.3.4.3 Aspect 4: Indicators of progression of technology areas

I mentioned in Session 1 (Aspect 3) that the teacher focused on *brief development component*. In the second session, the focus was on *planning for practice component*, which is an indicator of progression for the technological practice strand (Level 1).

The observation sheet included three indicators of students' performances in this session. Firstly, students were able to describe what they had done already. I noticed that the students were able to talk about what they discussed with their teacher during the previous session (Session 1) and they were aware of the work they were going to do. For example, when Jude showed them the craft knife and the scissors, one of them said, "We will use them to design a house for the gecko." Students were also aware of why they needed to build a house, one of them said "We want to save the gecko and help it to be warm and healthy." Secondly, students could identify what they would do next because the teacher had discussed it with them: "Draw a house on a sheet and describe every part in the design." I noticed that the students easily understood what they were to do and they started drawing the design on the sheet.

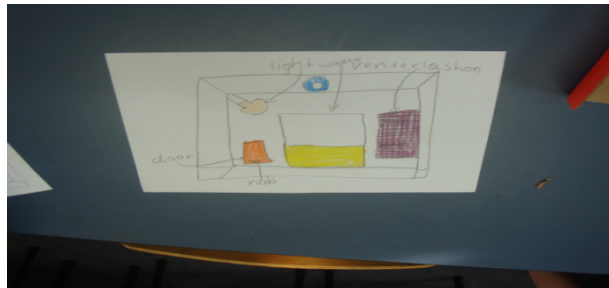


Figure 5.1: Students drawing the design on the sheet.

Thirdly, students can identify the resources they might use. At the beginning of this session, Jude discussed with her students the resources they would use and how they would use them; for example, a craft knife, scissors, a light bulb and a hot glue gun.

Furthermore, the observation sheet included three indicators that indicate the support that the teacher gives to her students. Firstly, Jude supported students to ensure that there is a brief against which planning to develop an outcome can occur. I noticed that she provided students with a brief of the house that they were going to build. The brief included two major parts: the conceptual statement and the attributes. The conceptual statement outlined the main problem to be solved: namely, designing a home for a gecko that will keep it safe and healthy. Jude identified some attributes that would help her students to think about how they build the house; for example, "The house must be designed so that your gecko cannot get out but you can get in to give it food and water. Also, the design allows you to

see inside the house and it must be colourful.” Secondly, the teacher supported students by providing them with a detailed plan of what they would be doing during technological practice. For example, she discussed the main issue and how they could solve it by following specific steps, such as thinking about the solution, thinking about the materials and drawing the suggested solution on the sheet. The third and final indicator was that Jude supported the students by providing a range of appropriate resources to select from. Regarding this indicator, I noticed that she encouraged students to think about the necessary resources of the model of the outcome, by asking them, “What are the resources that are important to build a house for the gecko?” One of students said, “A carton,” and Jude asked what else they could think of. Another student said, “A piece of wood.” Jude continued using this method until the students selected the resources they would use to start the project and to evaluate it in the third session based on those selected resources.

5.3.5 Third session

5.3.5.1 Aspect 2: The learning environment

The teacher managed the classroom using the same methods as established in the first two sessions. She informed the students that the goal in this session was to finalise the gecko’s house and to evaluate it. She managed the tables in a way that again helped her students face each other while each student worked on his or her model. There was significant interaction between the teacher and the students while they were working to evaluate the projects.



Figure 5.2: Students working to evaluate the design

5.3.5.2 Aspect 3: The process of teaching and learning

In this session, the focus was on the *development and evaluation component*. In this step, students evaluate the outcome against attributes. My aim in this session was to understand how the teacher and students worked together to evaluate the outcome against certain determined attributes.

Eight components were used to evaluate the process of teaching and learning.

1- Relation of materials to lesson objectives

The students used all the materials they had previously selected to evaluate the outcome and all of these materials relate to the lesson objectives. I noticed that the teacher and the students negotiated the outcome: a model for the gecko's house. The teacher asked the students to evaluate the outcome against attributes. For example, she asked them to compare the final outcome with the blueprint that includes the layout that the students drew to make the model.

2- Identifying lesson objectives

The teacher identified the objectives of this lesson, which included finalizing the project and evaluating it. The teacher informed the students that they were going to finish the project and evaluate it. She explained that evaluation means that student should assess whether his or her model is okay and can help protect the gecko, or whether something might be changed to make it work better.

3- Students' learning style

In this session, the students learned individually and collaboratively. For example, each student worked to evaluate their project by comparing it to the design that they had made, and each student also showed their own project to their peers and asked them what they thought about it.

4- Students' prior knowledge

The teacher took into account each student's prior knowledge in this session; she asked them about what attributes they had learned in order to design this enclosure.

5- Students' cultural consideration

The teacher did not take any action to consider this aspect in this session.

6- Using technological terms in the classroom

I noticed that the students used technological terms, such as design, model, properties of materials, problem solving. Also, attributes and evaluation were new terms that the students learnt about in this session.

7- Engaging students in authentic task

As mentioned in Sessions 1 and 2, the students were engaged in an authentic learning by being encouraged to practice a task that was relevant to their culture and life. I noticed that the students were enthusiastic and excited about this model because it reflects the authentic learning that touches students' need to learn about real things that exist in their environment.

8- Enhancing students' technological literacy

I noticed that the students were involved in an activity that aimed to evaluate the model that they made. Through this activity, the students learnt how to evaluate any small project and how such evaluation can affect the final model. This kind of activity is an essential aspect of technology education and plays a prominent role in enhancing students' technological literacy.

5.3.5.3 Aspect 4: Indicators of progression of technology areas

Three indicators of *outcome development component* help measure students' performance in this session. Students can describe outcomes, through drawing, models and/or verbally; they can identify outcomes in keeping with the attributes; and they could produce an outcome in keeping with identified attributes. To evaluate the product, the students were given a booklet called "My Technology Learning Journal". This booklet helped students evaluate the final outcome in keeping with identified attributes. It included these points: (1) problem; (2) design brief; (3) information hat; (4) creative hat; (5) good points hat; and (6) problems hat. The hats refer to the six-hats thinking system developed by Edward de Bono (1995) to improve ordinary thinking to become creative thinking. The thinker can

alternate between these six metaphorical hats to indicate the type of thinking that is being used. A white hat indicates data gathering; a red hat indicates intuition and emotions; a black hat indicates logical negative, judgement and action; a yellow hat indicates the logical positive benefits a green hat indicates provocations, alternatives and creativity; and a blue hat indicates the overview and process control. Jude asked, “Once you have done your gecko’s home, what thinking hat would you put on?” One student said, “what good points, we put on the yellow hat.” The booklet also included some questions that help students to evaluate the outcome. For example: does this house protect the gecko? Can I see it from inside? Is it colourful?

According to the *outcome development and evaluation component*, there are also some actions that teachers should take to support students to undertake outcome development and evaluation at Level 1. These actions helped me to observe how the teacher supported students to evaluate the final outcome. The first action was that she supported students to ensure that there was a brief with attributes against which a developed outcome could be evaluated. I noticed that she advised students in relation to the design they had made. Jude said, “If you have finished, you need to look at your design and think about whether there are any changes you need to make.” She reminded them of attributes they had agreed upon to design this product. She said that the final design should reflect the following attributes:

- There must be a place for your gecko to hide;
- Your home must be designed so that your gecko cannot get out, but you can get in to give it food and water;
- You must be able to see inside your home, and
- It must be colourful.

The second action was that Jude supported her students to establish an environment that encourages and supports student innovation when generating design ideas. This was obvious when she expressed admiration that all students had made good efforts to design a house to save the gecko. She said, “What wonderful ideas and designs you have made to achieve this goal.”

The third action was that the teacher supported students to provide opportunities to develop skills required to produce their outcomes. She had invited a parent who had experience using a hot glue gun to attend this session. This parent trained students how to

use this device safely and properly. Jude encouraged students to learn this skill because it is useful for creating other things. I noticed that during the three sessions that there were some talented and gifted students who had greater ability to work than other students and they expressed that this model was easy to make. However, those students were not given sufficient attention by the teachers. Acknowledging, praising, and giving them advanced activities would help develop their thinking and practical skills. Also, gender bias was not addressed by the teacher when she planned to teach this topic.

5.4 Year 6 Class Observation Findings

The observation took place in a Year 6 classroom that had 26 students. The topic was about robotics using sensors and the focus was on control area (Level 3). The robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer (Oxford Dictionary, 2015),

I set out what was observed in the classroom according to the four following aspects: (1) general information about the class observed; (2) learning environment; (3) process of teaching and learning; and (4) Indicators of progression of teaching technology; see Appendix (5A). Aspects 3 and 4 will be only reported on in Sessions 2, 3 and 4 because Aspects 1 and 2 are common information of the following sessions.

5.4.1 First session

The first session was about introducing the unit to the students by involving them in the discussion. The unit was about operating robotics using sensors. I explain what I observed in each session according to the observation aspects included in the observation sheet.

5.4.1.1 Aspect 1: General information about the observed class

Before I start observing the classroom, I sat with the teacher to collect some general information about the classroom, namely: session date, time, technology education area, topic, and focus of learning the unit. The topic was about operating robotics using sensors that represent the technological knowledge strand (technological modelling and technological system components), which was the focus of learning of the unit. Technology education in New Zealand involves many areas of learning, including control,

food, ICT and structural. Thus, teaching this topic was associated with ‘control’ as one of technology education areas.

5.4.1.2 Aspect 2: The learning environment

1- Teacher efficacy and knowledge of teaching

The teacher (referred to herein as David, which is not his real name) has a BA in sociology and a NZ Teaching Diploma from New Zealand Graduate School of Education. He has also attended several training programmes related to ICT.

2- Unit plan

The teacher prepared a ‘technology unit plan’ for teaching this topic. In this plan, the teacher identified several aspects that were crucial to teach this topic: achievement objectives, learning outcomes, teaching and learning sequence, resources, and assessment. The plan components were similar to the plan used by the teacher observed in the Year 2 classroom. The plan included an area of technology education taught in this unit – a “control area” – which aims to help students to know how to build and control the robot.

Achievement objectives were also a major part of the “technology unit plan”; that is, the three strands of technology education: technological knowledge, technological practice and nature of technology. The focus in this unit was only on Level 3 of the technological knowledge strand, including its three components: technological modelling, technological products, and technological systems. Technological practice and nature of technology were not implemented in the classroom that indicates that the teacher also had a narrow view of implementing technology education into classroom.

In the teaching and learning sequences column, David explained how the students would work to complete this task and what they would need. For example, in terms of the first learning outcome – “students can build a moving robot” – he indicated that they need to have a sensor close to the ground. They would also need programme sensors that help the robot detect what is happening around it.

The “unit plan” also included three resources used to teach this unit. Lego Nxt was a series of kits containing software and hardware for creating modifiable, programmable robots.

The main part is the *brick*, which contains a computer that controls the system. The kit also contained a set of interactive servo motors (a rotary actuator that allows for precise control of angular position), ultrasonic touch sensors, a rechargeable battery, connecting cables, convertor cables, and lamps. The second resource is apparatus for the various challenges to students based on each student's ability. The last resource was the five laptops necessary for programming.

According to David's plan, the assessment was the last column in the unit plan and showed how he would assess their students' performances after they had completed the project. He indicated that the assessment would be done through observations and challenge tick-lists.

3- Classroom management

In this session, David was able to manage the classroom in a way that contributed to a suitable classroom atmosphere. He encouraged students to be involved in a discussion in which all students felt included, valued and respected. I noticed that he encouraged the students to discuss the topic and told them to feel free to answer even if they were not sure about the answer. All students sat on the floor and David sat on a chair in front of them. He looked at every child in the class to make sure that he or she engaged in the discussion; this is a positive aspect of non-verbal communication.

4- Type of pedagogy used

David used a variety of pedagogical methods to enrich students learning through using problem-based learning, enquiry learning, discussion, collaborative learning, and individual learning. For example, he showed them the robot and asked them, "Have you seen this device before? What are its parts? How can we run it? What are the items we need to run it?" The students agreed that the topic would be about operating robotics using sensors. The students then discussed with David the process they would use to learn how the robot could be run.



Figure 5.3: The students sit around the teacher who introduces the project for them

5- Teacher's interactions with students

David interacted with the students regularly throughout the learning process. On different occasions during this introductory lesson he discussed how they would make the robot go around instead of going forward and backward; this gave students the opportunity to interact with him. When the teacher asked what we need to make the robot go around? One of the students answered, "Plugging the robot into the computer and downloading the program".

6- Students' interaction with the teacher

The students appeared to be motivated to learn how the robot runs. I noticed that the students appeared engaged and enthusiastic about their learning. This was illustrated in several ways. For example, they were enthusiastic about answering the main question: "Have you seen this device before?" The majority of students answered yes because they had learned about it in Year 5. Some of the students had not seen it before because they had attended other schools.

7- Students' collaboration with peers

I noticed some collaboration between students who were sitting in groups; they asked each other about the parts required to run the robot. For example, student asked another student, "Do you know what the 'sensor' was and how can you use it to run the robot?"

8- Using thinking skills in learning

David encouraged his students to use creative and critical thinking to design the robot and to make sense of information and ideas. He provided students with opportunities to help others to use thinking skills in learning. For example, he gave them time to think before they answered the questions. When David asked, "What are the key things you need to do when building a robot?", the students' answers were: (1) follow the instructions; (2) make

sure the wheels are spinning; and (3) make sure the cables are put in the right holes. David then asked, “Do you have any other important advice?” This statement gave the students the opportunity to think carefully about the topic under discussion.

9- Adequacy of technology materials to meet lesson objectives

All related materials were made available for the students to learn in an effective way: bricks, motors, robot software (mind storms), laptops, cables, sensors and large white sheets.

5.4.1.3 Aspect 3: Process of teaching and learning

Eight components were used to evaluate the process of teaching and learning.

1- Relation of materials to lesson objectives

Building a moving robot requires a variety of materials that help students to complete this project. The teacher discussed with the students what materials they need to complete this project. The teacher and the student talked about Lego Nxt that included different materials to run the robot.

2- Identifying lesson objectives

The teacher described the expected learning outcomes that reflect the achievement objectives. For example, he asked his students what they will do, why and how.

Students could achieve five learning outcomes after finishing the unit: (1) build a moving robot; (2) program a robot to move in a very precise manner; (3) programme light, radar and other sensors; (4) reflect on performances, revise programmes and show analytical skills and perseverance to complete the challenges; and (5) design and build a robot to solve a relevant problem at their school.

3- Students’ learning style

Discussion, individual and collaborative learning were evident in this session. The teacher introduced the topic by discussing what the robot is and what it is used for. He then encouraged students to learn individually how they can construct the robot and then work together to help each other to build the robot to make it ready to run.



Figure 5.4: Students were engaged in collaborative learning

4- Students' prior knowledge

David considered the students' prior knowledge about robots in this session. He started the introductory lesson by asking, "Who did the robot last year? Please raise your hand if you did that". Then he asked them about the basic things they had learned about robots, such as the USB and the brick including its parts (codes, motors, cables and the sensors).

5- Students' cultural consideration

I did not notice any emphasis on the element of students' cultures and the influence of that culture on their learning in this session.

6- Using technological terms in the classroom

I observed that both David and the students used several technological terms in this session, including design, model, properties of materials, problem solving, systems, programming, challenges, and thinking.

7- Engaging students in an authentic task

The robot has become one of popular technologies that help people solve problems. Therefore, teaching this topic helped to engage students in authentic learning that helped them understand what a robot is and how it can be programmed to do a certain task.

8- Enhancing students' technological literacy

The content of this topic helped to enhance students' technological literacy by engaging students in a task that represents technological knowledge as a main strand of the technology education concept. Students learned about the input, system, and the output,

which are among the purposes of teaching technology education that aim to enhance students' technological literacy.

5.4.1.4 Aspect 4: Indicators of progression of technology areas

The focus in this session was on the first component of the technological knowledge strand – *technological modelling*. I used the indicators of the progression sheet to observe how this component is delivered in the classroom and to compare that with the indicators listed in the indicators progression sheet. There are three indicators: (1) What the students are expected to achieve; (2) the support the teacher is expected to give his students; and (3) achievement objective of learning technological *modelling*.

In terms of the first indicator, I noticed that students discussed with David some forms of a functional model of a robot that they had learnt in Year 5. For example, one student said, “Last year we designed different moving robots but they go forward and backward and it does not go around.” This reflects that students learned how to discuss examples in order to identify the different forms of functional models used to gather specific information about the suitability of design concepts. This example also reflects what support the teacher is expected to provide to his students. He provided them with opportunities to explore different forms of functional modelling. For instance, he explained that they would go through different models and different challenges in using the robot and every model would depend on the information used to programme the robot. He also discussed with his students the specifications of the parts used to build the robot. For example, he provided them with information about the sensors and how they help the robot to move, touch and hear.

According to the Ministry of Education (2007), the general goal of teaching the achievement objective of *technological modelling component* is that students “understand that different forms of functional modelling are used to inform decision-making in the development of technological possibilities and that prototypes can be used to evaluate the fitness of technological outcomes for further development” (p. 42). At the end of this session, I noted through my discussions with some students that they had become aware of different forms of robots that could be created based on different information. For instance, one student said, “Now I can move the robot where I want to by reprogramming it.”

Students also became aware that the modelling they make is the model that is used as a prototype of the final product. For example, two students told me, “We are testing this robot to see if it runs according to the information that we put into the computer or not, and then we will try to develop it to be the final robot.”

5.4.2 Session 2

5.4.2.1 Aspect 3: Process of teaching and learning

In this session, the focus was on the second component of the technological knowledge strand: *technological products component*. The task was the first challenge; that is, to programme the robot to follow a path and then turn right. Students used special software that helped them to programme the robot to go in the desired direction.

1- Relation of materials to lesson objectives

Students used special software (sensors) that helped them to program the robot to move in the desired direction. The students reported that this software was suitable for this task.



Figure 5.5: Students listen to the teacher to learn how to programme the robot.

2- Identifying lesson objectives

The teacher described the expected learning outcomes of this session. He said that there are 10 challenges that every student should go through. These challenges were about moving the robot in different directions that ranged in complexity.

3- Students' learning style

Problem solving and collaborative learning were evident in this session. The students were divided into groups to solve problem (challenges). I noticed that the students employed different types of teamwork to overcome these challenges.



Figure 5.6: Students work collaboratively to solve the problem (challenges)

4- Students' prior knowledge

The teacher started this lesson by asking students about how they could make the robot run in different directions. He asked, “What helps you make the robot change direction?” Two of the students were able to respond to this question; they said that sensor is needed that helps to move the robot.

5- Students' cultural consideration

I did not notice any emphasis on the element of students' cultures and the influence of that culture on their learning.

6- Using technological terms in the classroom

Both David and the students used several technological terms in this session, including problem solving, systems, programming, challenges and thinking.

7- Engaging students in authentic task

As mentioned in Session 1, teaching this topic helped to engage a student in authentic learning that helped students understand what a robot is and how it can be programmed to do a certain task.

8- Enhancing students' technological literacy

The content of this topic helped to enhance students' technological literacy by engaging students in a task that represents problem solving as one of the applications of technology education. Students learned about how they can move the robot in different directions. This was not an easy task and it pushed students to think deeply in order to solve some problems that they faced while dealing with these challenges. I noticed that the teacher asked the students to go through four challenges that ranged from easy to difficult. Each challenge was drawn on a sheet that showed the direction that the robot should run through and the students needed to use the computer to program the robot according to this direction.

5.4.2.2 Aspect 4: Indicators of progression of technology areas

I used an indicator of progression sheet to observe how this component is delivered in the classroom and to compare what I observed with the indicators in the indicators progression sheet: (2) What students are expected to achieve; (2) what support is expected from the teacher; and (3) the achievement objective of learning the *technological products component*.

In terms of the first indicator – “students can describe of the properties of materials used in particular products that can be measured objectively” – I noticed the students were able to describe the properties of materials used in building a moving robot. For instance, I asked a group of students who were working together, “What are you doing, and what materials are you are using for this task?” They answered that they were trying to programme the robot to run using the Mindstorms software. “Also, we have this path on the sheet that the robot will run over.” They were able to describe how the properties combine to ensure the materials allow the robot to be technically feasible. For instance, some students explained to me which materials they would use to make the robot run properly. One said, “I have the brick, back wheel, front wheel, cables, and sensors. All these things must be used together to run the robot.” The students described that the robot would be linked to the computer to download the programmed data that allow the robot to work properly according to a specified plan.

In terms of the support expected from the teacher to support his students, David provided them with a variety of technological products and explained how properties combine to make the product technically feasible and socially acceptable. He also advised them that the fitness for purpose of this product relies on the materials used to create the product. I noticed that David prepared different challenges, each of which reflected a particular product, and he discussed with the students how to combine these materials to ensure the product runs smoothly. For example, he advised them to make sure that the robot was strong enough by choosing suitable parts that make it drive properly and turn easily.

In terms of the achievement objective of *technological products*, the Ministry of Education (2007) indicated that the general goal of teaching this component is that students will “understand the relationship between the materials used and their performance properties in technological products” (p. 42) Through my discussions with some students at the end of the session, I noticed that they became aware of the purpose of each material used to build a robot.

5.4.3 Session 3

5.4.3.1 Aspect 3: Process of teaching and learning

In this session, the focus was on the third component of the *technological knowledge* strand: *technological systems*. In the first session, the students had learned to control the robot; in the second they started to understand how to use the sensors. In this third session, they learnt through different challenges how to use sensors to produce and develop different models.

1- Relation of materials to lesson objectives

Students used the same materials identified in session 2 that helped them to program the robot to go in the desired direction. These materials included the software and various sensors.

2- Identifying lesson objectives

David described the expected learning outcomes of this session. He said that, in this session, all that the students had to do was to complete the challenges. He did not require

them to do complete all of the challenges; every group could stop at the level that it had reached and it could go beyond that.

David started this lesson by asking students about how they can make the robot run in different directions. Asked the students what helps the robot change direction. I noticed that two of the students were able to answer this question, saying that special software was required.

5.4.3.2 Aspect 4: Indicators of progression of technology areas

There are three indicators: (1) what the students are expected to achieve; (2) what support the teacher is expected to give his students; and (3) the achievement objective of learning the technological products component. In terms of the first indicator, “students can describe what the ‘black box’ refers to within a technological system and particular black boxes within technological systems.” I noticed that students were able to describe the components and how they are connected to allow a particular system to be technically feasible and socially acceptable. David and the students discussed the components that help the robot move in order to understand *how* it moves for a specific time and stops at a specific area. For instance, the students learned how the light sensor and the ultrasound sensor work to help the robot move and stop when it is exposed to a source of light or a source of sound. They learned the functions of each button of the software and how it can work with other buttons to move the robot and stop it when it runs over different lights. For example, they designed a model that moved forward without limitation but stopped when it crossed a dark area on the sheet. In general, they learnt how the internal parts of the robot and the software (black box) work together to perform a particular task. In addition, I noticed that the students were using specialised language to describe the product they had made. These included ultrasound, sensors, challenges, light source, sound, source and command terms to describe the product.

In terms of the support expected from the teacher to support his students, David guided them to understand that the fitness for purpose of a technological system relies on the selection of components and how they are connected to ensure the system is working properly. This was evident when he explained to them the components of the software used to programme the robot and the parts used to move the robot. He taught them how to

understand the function of each component and how it can work with other parts to move the robot. For example, David said, “This button makes the robot understand the colour of the light it will pass through and choosing a wrong colour will create an error in the system.” David also gave students the opportunity to use specialized language to describe and discuss the product with him and with each other.

According to the Ministry of Education (2007a), the achievement objective of this component is that students will “understand that technological systems are represented by symbolic language tools and understand the role played by a black box in technological systems” (p. 42) I noticed at the end of this session that the students had a better understanding of the technological systems of the robot and how the internal parts work together to represent a particular model based on the type of the challenge given to them.

5.4.4 Session 4

The main goal of this session was to enable the students to practice what they had learned and to continue evaluating themselves using the evaluation sheet prepared for this purpose. The teacher also evaluated the students according to the challenges that each one had completed. Most students had completed two of four challenges, while three students completed all four. David explained in the evaluation sheet what obstacles each student had faced so that they could work on them in the future. I perceived that some students were able to identify the problems they had faced and how they might solve them. For instance, one of the groups articulated that the robot did not move, which could have been because one of the wheels was not fixed as it should have been. Another group indicated that the sheet was not suitable for performing this task because it is small, which meant that robot could not move easily in a limited space.

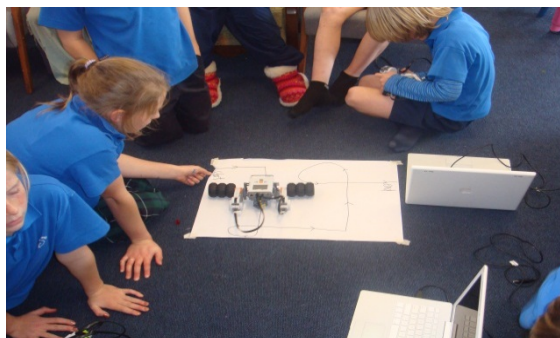


Figure 5.7: Students evaluate themselves according the challenges given to them

I noticed during the four sessions that there were some talented and gifted students who had more ability to work than other students and expressed that the model was easy for them. However, those students were not given sufficient attention by the teachers. Acknowledging, praising, and giving them advanced activity would help develop their thinking and practical skills. Also, gender bias was not addressed by the teacher when she taught this topic.

5.5 Interview Findings

I believe that it is important to understand people's perceptions of technology education in order to perceive the extent to which the current teaching of technology actually reflects the theoretical framework for the subject, as given in the 2007 Curriculum (Ministry of Education, 2007a). In this section, I draw from the interview data that helped me to answer the first sub-question regarding the New Zealand context. This sub-question was, "How is technology education implemented in the New Zealand primary curriculum?"

In this section I have used pseudonyms to maintain the privacy of participants and their institutions (see Table 5.4). Headings are designed to be consistent with the study's questions.

5.5.1 Participants' Backgrounds

I start by introducing the participants and technology teachers, before presenting the common themes produced from the interviews. Quotations from the interviews' transcripts are presented to support these themes.

Table 5.2: Pseudonyms of the participants and their roles

Participant	Position
A: Jude	Primary teacher
B: David	Primary teacher
C: Kate	Technology expert
D: Andy	Technology Expert

Participant A: Jude

Jude has been working at her school as a full-time technology teacher of Year 2 students for seven years. Jude graduated from the College of Education at Canterbury University and has a Bachelor of Learning and Teaching degree. She also attended some short

training programmes at Canterbury University. She said she is enjoying teaching technology education for junior students because it helps them to learn practical and technological thinking from an early age.

Participant B: David

David has a Bachelor of Arts degree in sociology and a teaching diploma from the New Zealand Graduate School of Education. He has also attended several training programmes related to ICT and has been teaching technology for five and a half years. He teaches technology for Years 5 and 6 students at his school. He said he is happy as a technology teacher because he believes that the subject is important.

Participant C: Kate

Kate trained at Christchurch Teachers' College in Primary Teacher Education, specialising in physical education. She started her career teaching technology education in primary and secondary schools. Most of her teaching in primary schools was in Years 7 and 8. She obtained a Master of Education degree and has been a lecturer of technology education at an education college since 1998. She worked for the college as a facilitator and advisor in technology education. Before that, she was involved in developing and setting up a new programme teaching technology, based at Kaiapoi Borough School, for 18 months. She plays a prominent role in the network that fosters technology education in New Zealand through her evident efforts in this field.

Participant D: Andy

Andy graduated with a Bachelor of Science degree in geological and earth sciences/geosciences. In 1996 he joined the Science Department at Rotorua Boys High School as a relatively new teacher. He quickly recognised the potential value that the new learning area of technology could bring to the curriculum and he was given responsibility for its school-wide implementation. Andy gained a Royal Society Teacher Fellowship in 2001 and then took up a professional learning and development advisory position at the University of Waikato, covering the wider Waikato/Bay of Plenty/East Coast region. This led to him moving to Wellington with his family to take up a post as senior adviser and national co-ordinator of technology education at the Ministry of Education.

5.5.2 Emerging themes from the interviews with technology teachers

Technology teachers in New Zealand were asked to answer these questions:

- 1- Technology education has recently been taught as a separate subject in the New Zealand curriculum. Do you think this is good idea and, if so, why?
- 2- Do your students enjoy technology education?
- 3- What is the relationship between science and technology?
- 4- What resources do you use to teach technology education?
- 5- Can you explain the current situation of technology education?
- 6- Do you face any difficulties in teaching technology? If yes, what are they?
- 7- Could you tell me about the professional development of technology education: is it important for technology education teachers? If so, how is it planned and implemented?

The data was analysed manually thorough open coding to identify the themes and categories that emerged from the interviews. For example, the teachers were asked (question one) “ Technology education has recently been taught as a separate subject in the New Zealand curriculum. Do you think this is good idea, if so why?” Their answers were: Jude: “It is about the children **designing a product** and seeing if it works and, if it does not work, why not, and just watching them **create** something.”

David: “Because it is all very **hands-on and they are building or constructing or modelling things**, they can actually see what they are doing and they can relate it to things that happen in the real world.” In technology education modelling is used to explore technological ideas. Modelling includes all steps from initial brainstorming to three-dimensional mock-ups and prototyping final designs. The underlined phrases demonstrate the common ideas that led to the emerging theme 1: Teaching technology education engages students in design and modelling of authentic technological outcomes. Modelling is an essential and significant component of design. Both the above responses indicate modelling as it is defined in technology online “Is the testing design of ideas to see if they can contribute to a fit-for-purpose technological outcome” (Ministry of Education, 2016). In technological practice modelling can be thought of as a subset of design, therefore both teachers are talking about modelling and design ideas.

5.5.2.1 Emerging theme 1: Teaching technology education engages students in design and modelling of authentic technological outcomes.

Jude and David teach technology at the same school. They both revealed that they really enjoy teaching technology because it is about students' ideas that can be transferred into products. Jude said, "It is about the children designing a product and seeing if it works and, if it does not work, why not, and just watching them create something." David said, "Because it is all very hands-on and they are building or constructing or modelling things, they can actually see what they are doing and they can relate it to things that happen in the real world."

5.5.2.2 Emerging theme 2: Tangible objects attract students in technology classroom

Jude and David believe that students enjoy this subject and enjoy learning hands-on things. Jude articulated that her students enjoy this subject because it is about design and students usually like to touch things and think about them. David said that his students told him that they like technology education because they are dealing with and making tangible things.

5.5.2.3 Emerging theme 3: Science and technology complement each other

In this school, there is a junior and a senior syndicate of science and technology that organize teaching the two topics. Jude indicated that the school has a long-term plan for the year and each term they focus on a host area; technology might be the focus for one term and science in another. David revealed that in the past year they conducted a science topic on thermal insulation to teach students how we keep things hot or cold. That led to a technology challenge in which students had to keep food hot or cold and think about the materials they were using. David said it is interesting and easy to add technology to science and that the two areas complement each other.

5.5.2.4 Emerging theme 4: Technology education resources

Many resources are used to teach technology and science and technology teams work together to decide on these resources and offer them. Jude mentioned that she uses the New Zealand curriculum framework, technology curriculum support, different technology education books and the BP technology challenge (designed by the BP oil company), as well as online resources. David reported that not all resources can be available to the

students and he quite often asks his students to bring these resources to school; otherwise they would not be able to undertake the project.

5.5.2.5 Emerging theme 5: Current technology curriculum helped teachers in the classroom

Jude and David believe that the current technology education curriculum is clearer than it used to be and it helps them to teach technology without difficulties. However, David believes that the curriculum does not give the whole picture of technology education and it has very broad guidelines. He feels that he can teach technology without using the curriculum a great deal. David said, “In general, I do not depend on this curriculum; I have to create my own ideas to teach the class.” Jude believes that the previous technology education was “a wee bit fuzzy” and confusing, but now it is much better. She said that the current curriculum provides her with achievement objectives that are important for teaching technology.

5.5.2.6 Emerging theme 6: Technology education teachers face physical and financial issues faced by

Timetables, resources (the materials used to make products) and budgets were the main problems that the teachers face. David said that the crowded curricula did not allow enough space to teach technology: “Once you have done your literacy and your numeracy and other things you have to do, there is not a lot of time left in the day.” I asked him what, given that there are not many subjects in the New Zealand curriculum, he meant by the crowded curriculum. He said that there is an imbalance between the subjects in the timetable. For example, there are fewer sessions for technology education than for numeracy and literacy. Jude said, “Resources are sometimes limited and we ask parents to help us to provide them.” In addition, both teachers indicated that there is a special fund for technology education in the school. Although the school sometimes offers some funding to purchase materials, this is generally insufficient.

5.5.2.7 Emerging theme 7: Lack of teachers professional development

Jude and David believe that professional development is important for them in order to teach technology education as it should be taught. They indicated they were not involved

in any training course organised by the school. Jude articulated that she only attended training courses when she was at university and she would be happy if she were invited to attend any training course related to technology. David said that he did attend some training courses when he was working at Science Alive, which is a not-for-profit science and technology centre dedicated to promoting the value of science and technology to the public. He said these courses were about how technology is run for schools.

5.5.3 Emerging themes from the interviews with technology experts

Technology experts in New Zealand were asked to answer these questions:

- 1- Technology education has recently been taught as a separate subject in the New Zealand curriculum. Do you think this is good idea, and if so, why?
- 2- Can you explain the current concept of technology education in New Zealand?
- 3- What do you think about integrating technology education with other subjects such as science?
- 4- Do you believe there is a gap between theory and practice in terms of teaching technology education?
- 5- What suggestions do you have for improving teaching technology education in Saudi Arabia?

5.5.3.1 Emerging theme 1: Teaching technology as a distinct discipline

Kate and Andy believe that technology education is a distinct discipline and should be taught as a separate subject in schools. Kate said that there is knowledge in technology education that is not taught in any other curriculum. She said that the current curriculum (2007a) has identified that knowledge quite well. She also believes it has become essential to teach technology education as an independent subject because we live in a technological world. This subject, in her opinion, encourages students to work on and critique existing technology from ethical, moral and environmental perspectives. Andy justified his opinion about teaching technology by saying that technology has its own philosophical approach and its basis for being. He believes that technology is neither an applied science nor an applied art. However, he believes that technology relies on other bodies of knowledge in order to function. For example, it requires knowledge, skills and attitudes from arts, mathematics and other learning areas.

5.5.3.2 Emerging theme 2: The current concept reflects the entire concept of technology

In the New Zealand Curriculum (2007a), technology education has three strands that reflect the entire concept of this subject in the curriculum: technological practice, technological knowledge and nature of technology. Kate and Andy revealed that these strands reflect the entire concept of technology education in the curriculum. Kate explained that this concept offers a holistic view of technology education because it includes the three main dimensions of technology. These are the practical nature, which is about the making and the doing; the nature of technology, a critical part that students go through when evaluating what they have done; and the technological knowledge, which relates to knowing why students are doing things. Andy agreed with Kate that this represents the entire concept of technology in the curriculum and it covers all the concepts between Years 1 and 13.

5.5.3.3 Emerging theme 3: Different views of integrating technology education in the curriculum

The discussion here was about the participants' perceptions of integrating technology education in the curriculum. "Mucky brown paint" was a metaphor that Kate used to describe what the integrated curriculum looks like in the school. She said the curriculum looks like different colours mixed together in a pot. She explained, "I am not against putting the colours together but we want to see the rainbows and swirls." She believes that integration is good but the nature of technology should be clear for both teachers and students in a way that allows them to distinguish technology from the other subjects. Kate revealed that they are getting pressure from schools to integrate technology but said they cannot teach it in this way until the teachers know the separate components that distinguish technology from other subjects. She suggested three ways of teaching technology education: it can be taught as a separate subject, integrated with science, and a separate curriculum but integrated in delivery keeping specific curriculum content integrity.

Andy was against the idea of integrating technology with other subjects because when the students learn more than one subject at a time they may not be able to understand whether the root of the knowledge is from science, mathematics, arts or technology. He asserted that this can be avoided by teaching technology as a separate subject.

5.5.3.4 Emerging theme 4: There is a gap between theory and practice need to be identified

Kate said it is hard to comment on this subject but agreed there is probably a gap that must be identified in order to improve the teaching of this subject. She said what is good is that the theory of technology focuses on the authentic learning, which is connected to the culture, and this is what they really see in some schools. Andy indicated that there will always be a gap between theory and practice in every discipline, but the important thing is to know how big the gap is and how it quickly can be closed. Andy asserted that there is a gap between theory and practice in terms of technology in curriculum.

5.5.3.5 Emerging theme 5: Suggestions for teaching technology education in Saudi Arabia

Kate and Andy encouraged the idea of teaching technology as a separate subject in Saudi Arabia. Kate indicated that it would represent technology in its own character for the Saudi students. She felt it would be a good idea to start teaching technology in a few Saudi schools, after which it can be evaluated and expanded. This could be done either at primary school or in all schooling years at the same time. Similarly, Andy believes that it is vital to teach technology separately in Saudi Arabia, but that it should be led by research. He believes co-opting a core body of people who are committed to technology education is very important in order to implement this project. Andy also asserted that the educational policy must include technology education and how it works in schools. This policy can be developed by people involved in making decisions about including technology in the curriculum. Andy also believes that it is important to involve a professional community (engineers) in implementing technology in Saudi in order to represent technology well in schools.

5.6 Summary

In the New Zealand study, the findings obtained from documentary analysis, classroom observations, and interviews reveal how technology education was implemented in the New Zealand primary education. According the educational policy (national education goals), priority should be given to the development of high levels of competence in science and technology as one of essential learning areas.

The concept of technology education was developed and defined in the curriculum to improve students' technological literacy, which is the overall aim of teaching technology. Technology education, as with other learning areas in the New Zealand curriculum, has eight levels of achievements across the school years.

Classroom observation indicated that implementing technology education in New Zealand classroom generally reflects the educational policy and the New Zealand curriculum, which provides teachers with a guideline for how this subject should be implemented in the classroom. This implementation has significantly enhanced students' technological literacy by helping students achieve a minimum level determined for each school year and has also encouraged them to achieve high levels based on the capability of each student. However, the teachers did not give more attention to the nature of technology, which is a key strand of technology education that should be taught as a whole concept in classroom. Moreover, talented and gifted students and gender bias were issues that were not addressed by the teachers. Addressing these issues can ensure that technology education is taught in a way that meets students' needs based on their ability and their gender that would affect their learning in a technology education classroom.

Findings from interviews with teachers and experts show that they had positive attitudes regarding technology education and they considered it an important subject in the New Zealand curriculum. Technology education teachers enjoyed teaching current curriculum despite some of the difficulties they faced in terms of resources and professional development. In contrast, technology experts, who were interviewed, believe that the current technology education reflects the overall concept of technology education, but they have different perspectives of teaching technology education in the classroom. However, they both suggested that teaching technology education separately is good idea for countries that want to include technology in their curricula. Findings from the analysis of documents and classroom observation will be compared to the findings obtained from Study 2 in Saudi Arabia; see Table 5.25.

5.7 Phase 2: Findings of Study 2 in Saudi Arabia

This section includes the findings from the study conducted in the Saudi context. These findings emerged from the following four methods used to collect data: (1) Document analysis of Saudi education policy and textbooks of Science and technology education in

the Saudi Primary Curriculum; (2) interviews with science teachers and some science and technology experts; (3) classroom observation; and (4) a questionnaire distributed to the participants (science teachers, technology experts, technology tutors, and technology advisors in the Makkah Region) to understand their perceptions of technology education in the Saudi curriculum.

The findings generated by each method will be covered under a different heading.

5.7.1 Findings from documentary analysis

For this study, the educational policy and science and technology education curricula were important sources of evidence of how technology education was interpreted by decision-makers and educators, and the way these documents were presented to teachers. It was obvious from the educational policy that the Ministry of Education in Saudi Arabia manages an education system based on a particular policy. This policy is a physical document that includes all general guidelines for education in this country, including tertiary education (Ministry of Education, 1995a). It was created in 1970 in a document issued by the High Committee of Education Policy in Saudi Arabia. The committee defined education policy as the general guidelines that direct education and encompassed nine sections. This study focused on all articles that include any indication of science and technology to demonstrate the position of science and technology in the policy concerning primary education. An analysis showed that technology was mentioned in various sections and different articles of the policy, according to the Ministry of Education (1995a).

Section 1 of the policy covers the general principles of education in Saudi Arabia, and emphasises science and technology in general education. It states that knowledge and practical approach (technology) are among the important means of cultural, social, economic, and health development that promote Saudi Arabia to contribute to cultural progress in the world (Article 14, p. 7). It is understood from this article that the Saudi government considers knowledge and technology to be a means to develop the country help the country catch up with more advanced countries.

In Section 2, the general purposes and objectives of education, it is stated that schools should encourage students to search and think scientifically (Article 41, p. 11). Schools should offer scientific and technological skills to allow students to contribute in terms of

creating products (Article 59A, p. 14) and allow students to study scientific principles that help to improve the creative level (Article 59B, p. 14). Here there is also an emphasis on scientific research and creative thinking by requesting schools to provide students with these scientific and thinking skills that I believe are the key factors that shape the concept of science and technology education.

Section 3 covers primary education objectives. Article 78 (p. 17) states that one of the objectives of primary education is to foster the creative skills of students and to help them to appreciate practical works. The policy in this article takes into account creativity, which is one of the goals of technology education. Providing students with creative skills will help them become innovators. I believe that this is what we expect from schools that must develop the capacities of students to become innovators.

Further, Section 5 of the policy (Division Three, Articles 157–162) clearly identifies the principles of the technical education that contribute to preparing and encouraging those who work in the agricultural, commercial and industrial fields. In Saudi Arabia, technical and vocational education is separate from tertiary education and general education. The Ministry of Higher Education and the Ministry of Education were recently amalgamated to become one Ministry, the “Ministry of Education.” Despite this positive move to reform education in Saudi Arabia, I submit that the Ministry of Education has not prepared a good strategy. The strategy does not provide students with minimum practical and technical skills that suit their ages or help them deal with technology when they want to continue their education at technical and vocational training institutes. Merging technical and vocational training institutes in Saudi Arabia with the Ministry of Education may increase the effectiveness of education by offering a comprehensive education. This comprehensive education can be managed by uniting teams from different sectors in education to draw a strategic plan of education. This plan could provide guidance and inspiration regarding what the ministry focuses on. This strategy must include clear and connected goals of education from the early childhood education to tertiary education.

5.7.2 Science and technology education in the Saudi curriculum

In Saudi Arabia, all curricula are determined by the Ministry of Education for both boys and girls schools, which provides schools with the titles of these subjects and their content. The Ministry prints the relevant textbooks every year and sends them to the schools.

Teachers must deliver these curricula without excluding any part of the content or including any other. In terms of science and technology in primary education, the Ministry of Education attempts to reform science education by adopting high-quality textbooks based on Western (specifically, American) experiences (Almutairi, 2014).

In this section, I present results from the analysis of the textbooks of the developed science curriculum in primary schools to explore the objectives and the content of each textbook from Years 1–6 and the scientific and technological topics included in them. The developed science curriculum is an outcome of the science curriculum development project that has been implemented by the Saudi Ministry of Education and the McGraw-Hill Company; the first implementation was at Year 4 in 2011.

I analysed the content based on two dimensions: (1) reading textbook introduction to explore how science and technology term was stated in the objectives; and (2) the number of topics related to technology. I also used the science and technology domain, including its three standards identified by Al-Ghamdi (2012), to analyse science and technology curriculum content. The three standards that Al-Ghamdi identified that can be used to analyse science curriculum in terms of science and technology domain are: (1) development of technological design skills; (2) understanding the relationship between science and technology; and (3) understanding applications of science and technology. I believe that these indicators represent the general concept of science and technology that curriculum developers should take into account in order to develop science and technology curriculum content. These indicators can be used as a useful measurement to analyse the content of a science and technology curriculum to understand the nature of these curricula in terms of teaching science and technology.

The analysis showed that these three standards were not addressed by science and technology in the curriculum. However, the third standard – “understanding applications of technology” – was addressed once in Year 6, three times in Year 5, twice in Year 4, three times in Year 2, and three times in Year 1.

Two aspects of science and technology curriculum were analysed to explore the extent to which science and technology curriculum support the concept of technology education in primary curriculum. These aspects were (1) objectives of science and technology, and (2)

science textbooks content in primary education. Analysing these aspects helped me explore the amount of topics related to technology education in primary science textbooks. Findings related to aspects one and two can be seen in Appendices (9) and (10). Table 5.5 shows a summary of the amount of technology topics in primary science textbooks in Terms 1 and 2.

Table 5.3: Summary of the number of technology topics in primary science textbooks, Terms 1 and 2

Years	Concept of science included in the objectives	Concept of technology included in the objectives	Number of topics related to technology	
			Term 1	Term 2
Year 6	Included	Included	No topic related to technology was included in the content taught in Term 1	Section 9: Material classification Lesson 1: The physical properties of the material
Year 5	Included	Included	Section 6: Earth resources preservation. Lesson 1: Fossils and energy	Unit 6: Powers and energy Section 11: Energy and simple machines. Lesson 1: Work and energy Lesson 2: Simple machines Scientific vocations: Mechanical engineer/ automobile mechanic. Reviewing Section 11.
Year 4	Included	Included	No topic related to	Section Eight: energy

			technology was included in the content taught in Term 1	Lesson 1: Heat Lesson 2: Electricity Lesson 3: Magnetism
Year 3	Included	Included	No topic related to technology was included in the content taught in Term 1	No topic related to technology was included in the content taught in Term 2
Year 2	Included	Included		<p>Unit 5: The material.</p> <p>Section 9: View on the material</p> <p>Lesson 1: Material description</p> <p>Unit 6: Powers and energy.</p> <p>Section 11: Powers.</p> <p>Lesson 1: The powers that move things.</p> <p>Lesson 2: Magnetism.</p> <p>Scientific reading: The simple machines that simplify work.</p> <p>Reviewing section 11.</p> <p>Section 12: using energy.</p> <p>Lesson 1: Heat.</p>

				<p>Lesson 2: Discovering electricity.</p> <p>Science and technology and society.</p>
Year 1	Included	Included	Not included	<p>Unit 5: Material.</p> <p>Section 7: Materials around us.</p> <p>Lesson 1: Material properties.</p> <p>Lesson 2: Solid materials.</p> <p>Lesson 3: Liquid and gas.</p> <p>Science and technology and society: Scientific reading: the construction unit.</p>

5.8 Classroom Observations Findings

Years 5 and 6 were selected based on the rationale given in Chapter 4 for observation in this school. The observations gave a better understanding of how technology education exists within science in primary schools. I attended classes that that were selected to conduct this study. I designed a suitable observation sheet that helped me to observe how science and technology are taught based on two aspects that were important to answer my research questions. These aspects were:

- 1- General information of the lesson including the topic title, date, time and objectives of the lesson
- 2- The learning environment, which consists of nine components
- 3- The process of teaching and learning, which consists of eight components

The observation sheet used in the Saudi classroom was identical to the New Zealand one. In the Saudi context, however, indicators of progress were not available to be used as one of the aspects of classroom observation.

I now set out what was observed in the classroom according to the aspects listed in the observation sheet; see Appendix (5C).

I observed how the teacher taught the selected topic by attending only one session relevant to technology education in each classroom, which also provided a general idea of how other topics would be taught in the subsequent sessions. The purpose of the observation was to see how technology teaching takes place in the science curriculum. This section includes the findings from the observations in Years 5 and 6.

5.8.1 Year 5 classroom observation findings

The observation took place in a Year 5 classroom that had 31 students. Ali, the teacher, has 18 years of experience teaching in primary schools and holds a Bachelor's degree in microbiology and a diploma in teaching. The topic (unit) was about preservation of Earth resources; the focused learning of the unit was on fossil fuels and non-renewable and renewable resources.

5.8.1.1 Aspect 1: Learning environment

Ali was able to manage the classroom in a way that helped create a suitable classroom atmosphere. He encourages students to become involved in a discussion in which all students feel included, valued and respected. The students were divided into five groups and the teacher remained standing throughout the class. The class was well managed and the students sat in clusters, although the common seating arrangement in Saudi classrooms is rows of desks. Ali was free to walk around the room without bumping into desks or chairs and could work with the groups. In terms of pedagogy, he used collaborative learning, discussion, and the lecture style to teach students, with the latter being the

dominant style. Ali allocated three minutes at the beginning of the session to collaboratively answer some questions related to the previous topic, then started the lecture in a style that sometimes included discussions.

There was a good level of interaction between the teacher and his students, with some students being positively involved in the discussion. The teacher interacted significantly with students through the learning process at different times. For example, during the introductory lesson he encouraged students to remember some examples of non-renewable and renewable resources. He began the session by asking what is meant by energy and asking for some examples.

The teacher divided the students into five groups and asked them to collaboratively answer some questions that aimed to review the previous session. Students discussed this and attempted to produce good answers.



Figure 5.8: Students working in groups to discuss the topic

Ali gave students the opportunity to think about the questions before answering. He asked, “What do we mean by the term ‘alternative energy’?” Students’ answers were that alternative energy refers to new energy and changed energy. Ali then invited other answers. This is an example of giving students the opportunity to think carefully about the topic under discussion. The allocated time to teach this subject and the long list of science curriculum content, determined by the Ministry of Education, did not appear help the teacher to focus on thinking skills that students should acquire and practise in learning.

Finally, all related materials were available to students to learn effectively: textbooks, data show, computers, and some models of fans that work based on solar energy.



Figure 5.9: Model of a fan operated by solar energy that shows how solar energy is transferred into electricity

5.8.1.2 Aspect 2: Teaching and learning process

The overall goal of this session was to help students understand how they could contribute to the preservation of the Earth's resources (fossils and energy). The teacher identified all learning areas and learning process in the unit plan, which consisted of seven items. These seven items were:

- 2- 1 - The lesson information (topic name, term, class, date).
- 3- 2 - Instructional aids: educational technologies and other materials used in the classroom to help the teacher teach the topic.
- 4- 3 – Concepts: the teacher listed some scientific and technological terms that students will learn about.
- 5- 4 - Learning process: The teacher used a penta-method in teaching. The penta method is a teaching strategy that is used to teach science and technology in primary education in Saudi Arabia, it covers five learning steps: preparation, investigation and exploration, explanation and interpretation, enriching and expansion. This method is recommended by the Ministry for teaching a new science curriculum (Ministry of Education, 2009a).
- 6- 5 - Lesson objectives: Students should: (a) understand how air energy can be transferred into another form of energy that moves objects and generates electricity by using windmills; (b) discover how the wind moves objects; (c) define “fossils”;

(d) understand fossil fuels; (e) distinguish between renewable and non-renewable resources; (f) understand how energy is produced from the sun, water and air; and (g) realise methods of energy saving.

7- 6 - Evaluation

8- Homework

The teacher started the lesson with a brief workshop that aimed to refresh students' knowledge about the previous topic, which had studied renewable and non-renewable resources. This part of the lesson allowed students to share knowledge with their peers. This activity was followed by a general lecture that dominated the learning process over the period (45 minutes). The penta-method was used to teach students. Ali divided the students into five groups and gave each group a piece of paper with the two following tasks: (1) provide some examples of non-renewable resources and (2) provide some examples of renewable resources.

Although this topic has a connection to technology, the lesson plan and the method of teaching were significantly relevant to science because the way knowledge is processed in science is different to the way it is processed in technology. In science it is processed through experimentation and theory creation, while in technology it is processed through design, invention and production as the implementation of theory in science; see the discussion about the relationship between science and technology in Chapter 3, Table 3.1.

No part of the learning process encouraged students to learn about technology. This was evident from the lesson objectives identified by the teacher: the plan only included objectives related to science, not technology. Technology objectives reflect the concept of technology education, which addresses different characteristics of technology education such as technological practice, technological knowledge, and nature of technology. They are also significantly associated with practical skills and problem solving.

Ali introduced this session by discussing with the students some information related to the previous session. He then began the session by introducing the topic, which was "Energy", with a focus on "Alternative Energy". Ali then asked the students what is meant by the term "alternative energy". Ali then told his students that they would learn about such types of energy as wind, water and solar energy. He used a projector to show some film clips that explained how electricity is generated by those means and he commented on the clips.

For example, he explained to students the basic parts of a wind turbine and how it generates electricity. Ali did not engage his students in a task to motivate them to design a windmill or to investigate the issues that may face them before developing that product further. However, he concluded the discussion about wind energy by encouraging students to think about the current windmills and how they could be improved. Students were not given the opportunity to develop technological thinking skills. I expect that if the students had been given such an opportunity to think about this windmill from a technological point of view, they would have learned about technological knowledge, which is a major part of technology education. Learning about technological knowledge means that students can understand how inputs, systems and outputs influence any technological product.

The observation showed that students discussed some positive and negative impacts of energy on the environment and ways of protecting it. The lesson included some technological terms – including solar energy, solar cells, energy production, electrical energy, wind and water energy – but Ali only connected them to science. If Ali had been aware of how technology integrated with science in the classroom, he would have shifted the discussion from science-based inquiry to technology-based inquiry. This would allow students to learn how those types of energy were addressed from a technological perspective.

The topic reflected the authentic learning and was relevant to the students' lives. The unit aimed to help them understand how to use energy wisely and to be a good example of conserving energy in their communities (homes, schools and public places). At the end of the lesson, Ali discussed with his students some ways of conserving energy, such as turning lights off before going to bed, turning devices off when not in use, and saving water, especially hot water. Ali gave them home activities to think about the resources available in their school and how to preserve them.

The topic was discussed based on the Saudi and international environments. The teacher gave examples of using alternative energy in Saudi Arabia, Iceland, and Algeria.

The teacher did not appear to be prepared to teach technology and he needed to cover a tightly-packed curriculum. He skipped any practical tasks to complete teaching the subject within the specified time, despite the curriculum including directions for a practical task on

this topic. Therefore, the students were not engaged in technological discussion that might assist their awareness of the concept of technology and technological topics. The evidence of not engaging students in technological discussion is that the topic was one of the applications of technology-based inquiry because the topic included some technological ideas and models, such as the solar energy model. But the teacher used the model as a simple practical basis to the class and did not give his students the opportunity to think about the input, output, or the system of this model and how they might design a similar model or develop a new model.

5.8.2 Year 6 classroom observation findings

This observation took place in a Year 6 classroom comprising 34 students. The topic (unit) was about preserving the Earth's resources, with the learning focus of the unit being on recycling, geothermal energy, biomass energy, hydroelectric energy, and solar energy.

This section explains the observations made in the classroom according to the aspects listed in the observation sheet: (1) learning environment, and (2) the process of teaching and learning.

5.8.1.3 Aspect 3: Learning environment

Ibrahim is a teacher with years of teaching experience in primary schools and a Bachelor of Science degree. He was able to manage the class in a way that contributed to make a suitable classroom atmosphere. He encouraged students to be involved in the discussion in which all students felt included, valued and respected. The students sat on chairs and were divided into five groups; Ibrahim remained standing throughout the class. The class was well managed and the students sat clusters. In terms of pedagogy, Ibrahim only used the discussion and lecture styles to teach students, with the latter being dominant.



Figure 5.10: Students sit in groups while the teacher discusses the topic with them.

There was a good level of interaction between Ibrahim and his students that allowed positive involvement in the discussion. He frequently interacted with students through the learning process at different times. For example, during the introductory lesson he tried to encourage students to define the term “alternative energy” and asked them to think of some types of that energy.

Ibrahim tried to give students the opportunity to think about the questions before giving the answers when he asked, “What are types of energy?” Students’ answers were: wind energy, solar energy and biomass energy. Ibrahim then invited any other answers. This is a good example of giving students the opportunity to think carefully about the topic under discussion. The allocated time and the large amount of content did not help the teacher to focus on thinking skills that students should acquire and practice in learning.

Finally, all related materials were available: textbooks, data show, computer, and some models of solar cells.



Figure 5.11: Model of solar cells used to show students how solar energy works

5.8.1.4 Aspect 4: Teaching and learning process

The overall goal of this session was to help students understand how they could identify ways to help preserve the Earth’s resources. The teacher identified all learning areas and the learning process in the unit plan consisting of the seven following items.

- 1 - Lesson information (topic name, term, class, date)
- 2 - Instructional aids
- 3 - Concepts
- 4 - Learning process: the teacher again used the penta-method described earlier.
- 5 - Lesson objectives: students should: (a) identify some ways of preserving energy, (b) deduce benefits of recycling, (c) explain the process of desalination, (d) account for

alternative energy resources, and (e) understand the three principles of preserving the resources of the environment.

6 - Evaluation

7- Homework

The teacher began the lesson by introducing the topic of “alternative energy” and the focus was on some related concepts such as recycling, geothermal energy, biomass energy, hydroelectric energy, and solar energy. Ibrahim asked his students, “What do we mean by the term ‘alternative energy’ and what are its types?”

The introduction was followed by a general lecture that dominated the learning process throughout the period (45 minutes). After the discussion, Ibrahim told the students that they would learn about types of alternative energy: geothermal, wind, biomass, hydroelectric and solar.

Ibrahim used a projector to show students some film clips that explained how electric energy is generated by wind, water and solar energy and he commented on the clips. For example, he explained to students the basic parts of a windmill and how it generates electricity. He then discussed the differences between the types of energy – geothermal energy, wind energy, biomass energy, hydroelectric energy, and solar energy – and how these types of energy could affect the environment. While Ibrahim and his students were discussing solar energy, a student asked, “Who invented this method?” Ibrahim was not able to answer. The discussion then shifted to fossil fuels and how people could reduce its use.

The lesson included some technological terms but Ibrahim only connected them to science; these terms included recycling, geothermal and biomass energy, hydroelectric and solar energy. Ibrahim did not refer these terms to technology or present the concept of technology within the classroom. He should direct his students to think about these aspects by using one or two aspects to learn about the technological products that have been designed in relation to these aspects. This would have enabled the students to learn about how these machines are technologically designed to solve certain environmental issues.

Therefore, the topic was based on scientific rather than technological context.

The topic reflected authentic learning and was relevant to students' lives. The unit aimed to help students understand how to conserve energy and how to implement the three principles of preserving environment resources: energy rationalisation, reusing, and recycling. At the end of the session, Ibrahim set students a homework activity to think about how recycling could help stop pollution. The topic was discussed based on the Saudi and the international environments. For example the teacher gave examples of using alternative energy in Saudi, Palestine and Algeria.

Ibrahim did not appear to be prepared to teach technology and skipped any practical tasks in order to complete teaching the subject within the set time. Although the curriculum does include specific directions for a practical task on this topic, the amount of time allocated by the Ministry of Education is not sufficient to do these practical activities compared to the amount of science and technology content. Therefore, the students were not engaged in technological discussion that might help them be aware of the concept of technology and technological topics. The topic included some technological ideas and models, such as the windmill and the solar energy model, but the teacher did not give the students the opportunity to think about the input, output, and the system of the model or how they might design a similar model or develop a new model.

Despite the topic's connection with technology, the lesson plan and the method of teaching were significantly relevant to science. The data obtained from classroom observation reveals that Ibrahim was not able to link technology with science to teach this unit. He used only science-based inquiry rather than technology-based inquiry.

Furthermore, no part of the learning process encourages students to learn about technology. This was evident from the lesson's objectives that Ibrahim identified: all of the objectives were related to science, not technology.

5.9 Interview Findings

5.9.1 Science Teachers' perceptions of technology education

In this section, I drew data from the interviews, which helped me answer the third sub-questions generated from the main question of the second study conducted in the Saudi

context. The second sub-question is, “What is the current situation of technology in Saudi primary education?”

In this section, pseudonyms have been used to maintain the privacy of participants and their institutions (see Table 4.7). Also, headings are designed to be consistent with the study’s research questions.

The participants are introduced below, followed by a presentation of the common themes produced from the interviews. Quotations from the interviews’ transcripts are presented to support these themes.

Table 5.4: Pseudonyms of the participants and their roles

Participant	Position
A: Ali	Primary teacher (Year 5)
B: Ibrahim	Primary teacher (Year 6)
C: Mohammad	Technology expert (Ministry of Education)
D: Tariq	Technology expert (Al-Qassim University)

5.9.2 Participants’ backgrounds

Participant A: Ali

Ali has been a science teacher in primary schools for 18 years and he currently teaches Year 5. He has a Bachelor’s degree in microbiology from King Abdulaziz University and a diploma in teaching from Um Al-Qura University. He is now in his eighth year at this school. He says that he enjoys teaching science and technology for both senior and junior students at the primary level.

Participant B: Ibrahim

Ibrahim has been teaching science in primary schools for nine years and he currently teaches Year 6. He has a Bachelor of Science degree from Teachers’ College in Jeddah. He taught in three schools before coming to his current school. In the three previous schools

he was teaching mathematics as well as science. In this school he has become a full-time science teacher. He loves teaching science and mathematics for primary students.

Participant C: Mohammad

Mohammad works as a curriculum advisor at the Ministry of Education in the general directorate of curricula/science department. He has 33 years of experience in education, including teaching, supervision and administrative roles. He graduated from King Saud University in 1981 (BCh). He has participated in developing the science curriculum in Saudi Arabia and has trained many science teachers.

Participant D: Tariq

Tariq is a professor of technology education at Al-Qassim University. He has extensive experience in teaching technology education. In 1987 he graduated from Alexandria University in Egypt with a Bachelor degree in chemistry. In 1990 he gained a diploma in education from the same institute and in 1994 he gained a Master's Degree in education, again from Alexandria University institute. He was awarded a PhD in education (educational technology) by Al-Minufiyah University in Egypt. He has published numerous articles in academic journals and has written many educational books.

5.9.3 Emerging Themes from the interviews with science and technology teachers

In this study I used the same process as previously explained in the New Zealand study section to generate themes from the interviews. This section outlines the findings from the interviews with technology teachers and technology advisors in Saudi Arabia.

Seven themes were generated from the interviews that reflected some aspects of teaching science and technology in the Saudi context. These aspects related to the pedagogy used to teach science and technology, technology education concept within science, ideas of teaching technology in primary schools, ways of including technology in the curricula, professional development of teachers, and technology education in the policy. These themes are significant because they represent technology education theoretically and practically. The teachers were asked the following questions.

- 1- Technology education has recently been taught as a separate subject in some countries, such as New Zealand. Do you think this is good idea? If so, why?

- 2- Do your students enjoy science and technology education?
- 3- What is the relationship between science and technology?
- 4- What resources do you use to teach science and technology education?
- 5- Can you explain the current situation regarding technology education in the Saudi curriculum?
- 6- Do you face any difficulties in teaching technology? If yes, what are they?
- 7- Could you tell me about the professional development of science technology education? Is it important for science technology education teachers? If so, how is it planned and implemented?

5.9.3.1 Emerging theme 1: Saudi teachers struggling to teach technology

Ali and Mohammed believe that teaching technology education is different from one country to another because every country has its own educational system. Therefore, they believe that, in Saudi Arabia, this subject has been integrated with science and we still struggle to teach it, for several reasons. Ali refers this issue to the entire education system, which does not support teaching technology education, while Mohammed noted that the lack of research showing the importance of teaching technology education has negatively impacted on the development of the curriculum in Saudi Arabia. Therefore, Mohammed and Ali both believe that although it is a good idea to teach technology education in other countries as a separate subject, it might not be such a good idea in Saudi Arabia. Ali explained by saying, “we first want to teach it properly with science; this will provide us with a good experience that will help the Ministry of Education to decide which way is better to teach technology.” Mohammed suggested, “This project must be conducted in some schools to identify the negative and the positive aspects of teaching technology with science; this will provide us with a clear direction on how this subject can be taught in classroom.”

5.9.3.2 Emerging theme 2: Tangible objects attract students in technology classroom

Ali indicated that the level of enjoyment differs from one topic to another. He said, “I feel that they enjoy it when I teach them about devices and tangible things.” Mohammed mentioned, “The crowded curriculum made the students enjoy science and technology less than other curricula.”

5.9.3.3 Emerging theme 3: Science and technology complement each other

Ali and Mohammed both understand that science and technology complement each other. Ali said, “Science is usually about the environment, while technology is about devices, and devices and equipment can be used to solve environmental issues.” Mohammed felt that there is no doubt that the two subjects are complementary. He said, “Science is about discovering laws and theories of events and these norms help to create technological products that help to solve problems in human life.”

5.9.3.4 Emerging theme 4: Technology education resources

Both teachers articulated that science and technology textbooks are the only key resources they use to teach this subject. They also indicated that they have a range of instructional aids that help to teach this subject, which are available in the school’s science lab. Mohammed revealed that he uses the internet as another source to teach this subject, but he added that he only focuses on one website, which is related to science rather than technology.

5.9.3.5 Emerging theme 5: Less attention given to technology education

Ali and Mohammed agreed that technology education has been integrated into the science curriculum, with less attention given to technology. Ali said, “This situation leads our students to be less creative and innovative learners because we do not provide them with the practical skills they need to improve their technological literacy.” Mohammed indicated that this situation “has led to more focus given to theory instead of practice; for example, the current science curriculum has few topics related to technology, so the majority of science lessons are theory-based rather than technologically-based.”

5.9.3.6 Emerging theme 6: Crowded curriculum and the absence of clear guidelines to teach technology

Timetables and the absence of technology education guideline resources were the main problems that the teachers face. Ali said, “The crowded curricula did not allow enough space to teach technology,” while Mohammed indicated that one of the main difficulties that he faces as a science and technology teacher is the absence of clear guidelines to teach technology with science. He added, “I expect that these guidelines would include

definitions of science and technology, the objectives of each branch, suggested teaching methods, the relationship between them, assessment, and the expected outcomes of each branch.”

5.9.3.7 Emerging theme 7: Lack of teachers professional development in technology

Ali and Mohammed believe that professional development is important for them in order to teach technology education as it should be taught. They indicated they were only involved in training courses that aimed to help them to teach science based on the penta-method, which covers five aspects of teaching science. However, they have not been involved in any training programmes related to the teaching of technology. Ali explained that before thinking about such training programmes, the curriculum must be reformed to include a clear concept of technology education. Mohammed believes that training courses are needed to help teachers understand how they can differentiate science from technology and then integrate the two subjects in the classroom.

5.9.3.8 Emerging themes from the interviews with technology experts

Mohammad, a curriculum advisor at the Ministry of Education, and Professor Tariq who teaches at one of the Saudi Universities were interviewed to explain their opinions of science and technology education in the Saudi curriculum.

5.9.3.10 Emerging themes from the interviews with science and technology experts

Technology experts in Saudi Arabia were asked the following questions.

1. Technology education has recently been taught as a separate subject in countries such as New Zealand. Do you think this is good idea and, if so, why?
2. Can you explain the current concept of technology education in Saudi Arabia?
3. What do you think about integrating technology education with other subjects such as science?
4. Do you believe there is a gap between theory and practice in terms of teaching technology education?
5. What suggestions do you have for improving teaching technology education in Saudi Arabia?

5.9.3.11 Emerging theme 1: Different views of teaching technology education as a separate subject

Tariq and Ibrahim were asked whether they believed that teaching technology as a separate subject was a good idea. Tariq felt that it might be a good idea for some countries but not for others, adding that it depends on the educational philosophy in each country. He feels that it also depends on the learning resources and entire educational environment. Ibrahim also indicated that teaching technology separately was not a good idea in the Saudi context because some of the teachers are not qualified to teach this subject. He also suggested that before we apply this idea we have to reduce number of subjects to allow enough time to teach technology education separately.

5.9.3.12 Emerging theme 2: Technology education is embedded with science

Both participants indicated that technology education needs to be given more attention because the focus so far has been primarily on science. Tariq revealed that the policy emphasised teaching practical activities and there is an emphasis on teaching technology among the objectives of science and technology, but what is actually taught in class is different and is all about science. Ibrahim agreed with Tariq that technology education has been embedded as part of science and the few topics that are related to technology are taught theoretically without linking these topics to technology.

5.9.3.13 Emerging theme 3: Different views about integrating technology education with other subjects

Tariq and Ibrahim had different opinions about the way of teaching technology education in the primary curriculum. Tariq believes that teaching it as a separate subject will allow students to be involved in practical activities; for example, they can use second-hand devices to explore parts of these devices and what is the role of each part and how they work together. He explained that this will help them achieve a better understanding of how these devices work, which is part of the technological understanding. In contrast, Ibrahim believes that teaching technology with science is an appropriate choice because we already have a range of subjects, so adding more subjects will increase the burden on students. He suggested either that science or technology be taught together, or that they be taught in different semesters; for example, science in semester 1 and technology in semester 2.

5.9.3.14 Emerging theme 4: Science and technology curriculum do not reflect the policy

Both participants believe that there is a gap between theory and practice in the teaching of technology education in Saudi Arabia. Tariq indicated that what is being taught in science is different to what the educational policy states in terms of science and technology. He revealed that the educational policy must be reviewed in order to respond to changes in society, especially in terms of science and technology. He also articulated that science and technology have been poorly identified in the policy, which has resulted in the failure to develop a curriculum that fosters the teaching of technology. Ibrahim criticised the current Saudi curricula, which focus on theory rather than practice. He said, “When you read the introduction of science textbooks, you can understand that students will learn about technology and practical skills, but what happens now is that technology and practical skills are absent from the classroom. He claimed that we must review the educational policy to consider teaching technology education by suggesting all steps that help to reduce the gap between theory and practice.”

5.9.3.15 Emerging theme 5: Suggestions for teaching technology education in Saudi Arabia

The participants were asked to provide some suggestions that might help the teaching of technology education in Saudi Arabia. Tariq indicated that technology education is an important subject that must be taught to Saudi students, rather than just subjects such as history and Arabic language. He suggested that the Ministry of Education should start to establish a research centre of science and technology that aims to investigate this idea and introduce it to schools. I told him that but there is a centre established for this purpose, it is affiliated by King Saud University but he replied that but we have not seen any good outcomes for this centre in terms of teaching technology education, he explained that this centre only focuses on science and mathematic rather than technology.

He also indicated that this idea could be implemented in certain schools then evaluated to avoid the negative outcomes and to enforce the positive outcomes. Mohammed suggested that different sectors should work together to think how technology education can be effectively implemented in our schools. For example, Ministry of Education, Universities, Technical Education, King Abdullah City of Science and Technology, these organizations

can investigate this idea in depth to establish a good foundation of technology education in the curriculum. Moreover, he suggested that offering online training for those who want to improve their skills to teach technology with science, this will be good idea because we have a big number of teachers who can not be trained face to face.

5.10 Findings From The Questionnaires

This questionnaire is comprised of quantitative and qualitative items (three open-ended questions) to explore the interviewees' perceptions about the current situation of technology education in Saudi education. Findings were grouped into several themes by bringing together statements with common ideas that support particular aspects of technology education and the interviewees' opinions about those aspects. Included under each category are the relevant statements obtained from the questionnaires; the full questions are included in Appendixes (6,7, and 8). This section also presents the findings of the open questions included in these questionnaires. The following three groups were chosen to participate in the survey:

- 1- Science teachers from the Almahd Region

5.10.1 Science Teachers' perceptions of technology education

Twenty-two male full-time primary school science teachers in the Almahd region received and responded to the questionnaire. Each question was a statement to which the participants responded using a Likert scale; see Appendix 6.

Table 5.5 represents the findings based on the following three statements: (1) "The technological revolution of the 21st Century requires governments to review curricula", (2) "The technological revolution will require schools to develop students' technological literacy"; and (3) "It is important that primary students be creative and innovative learners". The patterns of responses to the first two statements are very similar, with approximately two-thirds of respondents strongly agreeing and agreeing and none disagreeing. They suggested that governments (including the Saudi government) should respond to this demand and review the [Saudi] primary curricula to be modern and updated. They all indicated that the "technological revolution" would encourage primary schools to offer a subject or subjects that contribute to the development of students'

technological literacy. Furthermore, 54.5 percent of the respondents strongly agreed about the importance of creativity and innovation for the community and agreed that schools should prepare creative and innovative learners who can positively contribute to the industrial sector in the future; a further 22.7 percent agreed with this notion. A lower percentage of the respondents (18.2 percent) disagreed, saying they do not place any importance on this notion. Overall, this data suggests that the participants were aware of the technological revolution and its influence on education. Thus, technological literacy should be taken into account when the Ministry of Education in Saudi Arabia assess curricula to reform education.

Table 5.5: The influence of the technological revolution on education

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The technological revolution requires governments to review curricula.	15 68.2%	7 31.8%	0 0%	0 0%	0 0%
2	The technological revolution will require schools to develop students' technological literacy.	14 63.6%	8 36.4%	0 0%	0 0%	0 0%
3	It is important that primary students be creative and innovative learners.	12 54.5%	5 22.7%	1 4.5%	4 18.2%	0 0%

Table 5.6 represents findings of Statements 4 ("I understand the importance of teaching technology in primary schools for producing a technical generation"); 5 ("Including

teaching technology in the primary curriculum will help develop pupils' capabilities to solve technological problems by applying scientific and mathematical ideas"); 6 ("Including teaching technology in primary schools will help reveal pupils' professional capabilities"); 7 ("Without an understanding of technology, students may feel powerless and threatened"); 8 ("Primary school pupils would benefit from learning about the design of technological products"); and 9 ("Hands-on and practical activities contribute to making learning more fun"). All respondents agreed or strongly agreed with Statements 5 and 6. Similarly, 95.5 percent of respondents agreed or strongly agreed with Statement 7, but one respondent strongly disagreed. Statement 4 had more variation, with 27.3 percent disagreeing. No one disagreed or strongly disagreed with Statement 8, but 18.2 percent had no opinion. The majority (77.3 percent) strongly agreed with Statement 9 and there was no disagreement. Overall, the data in this table suggests that all teachers responded that including teaching technology in the Saudi primary curriculum brings many positive aspects that are crucial for education in Saudi Arabia.

Table 5.6: Positive aspects of including technology in primary curriculum

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
4	I understand the importance of teaching technology in primary schools for producing a technical generation.	6 27.3%	10 45.5 %	0 0%	6 27.3%	0 0%
5	Including teaching technology in the primary curriculum will help develop pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.	11 50%	11 50%	0 0%	0 0%	0 0%

6	Including teaching technology in primary schools will help in reveal pupils' professional capabilities.	11 50%	11 50%	0 0%	0 0%	0 0%
7	Without an understanding of technology, students may feel powerless and threatened.	11 50%	10 45.5 %	0 0%	0 0%	1 4.5%
8	Primary school pupils would benefit from learning about the design of technological products.	10 45.5%	8 36.4 %	4 18.2 %	0 0%	0 0%
9	Hands-on and practical activities contribute to making learning more fun.	17 77.3%	4 18.2 %	1 4.5 %	0 0%	0 0%

Table 5.7 represents the findings regarding Statements 10 (“Primary school students need to acquire knowledge that helps them keep pace with and understand technological change”) and 11 (“Primary students need to develop a wide range of technological knowledge and some basic technological skills”). There was a positive view of the general knowledge content of technology education: 54.5 percent strongly agreed that students need to acquire knowledge to help them to keep pace with technological change and understand the nature of this change in their community, while the other 45.5 percent simply agreed. None of the respondents disagreed with this statement. A majority (59.1 percent) strongly agreed that the general content of knowledge in technology education should include a wide range of technological knowledge and basic technological skills that are distinct in technology education from other disciplines. A further 36.4 percent agreed

that this type of knowledge should be delivered to the students. One respondent took a neutral position on this notion. Overall, this data suggests that all teachers claimed that schools must teach students knowledge that helps them learn about technology and understand technological change; this knowledge should include a variety of technological skills.

Table 5.7: Type of technological knowledge that students need to acquire

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
10	Primary school students need to acquire knowledge that helps them keep pace with and understand technological change.	12 54.5%	10 45.5%	0 0%	0 0%	0 0%
11	Primary students need to develop a wide range of technological knowledge and some basic technological skills.	13 59.1%	8 36.4%	1 4.5%	0 0%	0 0%

Table 5.8 represents the findings regarding Statements 12 (“Primary school students need to develop an appreciation of the importance of technology to Saudi Arabia’s economic development”) and 13 (“Increasing the number of technologists in Saudi would benefit further economic development”). Almost all respondents (95.5 percent) either strongly agreed or agreed with both statements. Overall, the data suggest that teaching technology in Saudi primary curriculum will positively reflect on the development of the Saudi economy.

Table 5.8: Teaching technology and Saudi’s economic development

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
12	Primary school students need to develop an appreciation of the importance of technology to Saudi Arabia's economic development.	10 45.5%	11 50%	1 4.5%	0 0%	0 0%
13	Increasing the number of technologists in Saudi would benefit further economic development.	14 63.6%	7 31.8%	1 4.5%	0 0%	0 0%

Table 5.9 represents the findings of Statements 14 (“Primary school students need an awareness and understanding of the interaction between technology and society”) and 15 (“It is important for students to recognize the environmental issues caused by technological developments”). There was significant agreement regarding this theme (“Building a bridge between students and society”) and total agreement (combined strong agreement and simple agreement) that primary school students in Saudi Arabia need to be aware of and understand the interaction between technology and society. Only one of the 22 respondents expressed no opinion regarding Statement 15. These results suggest that the Ministry of Education must consider this aspect as a major part of the curriculum, particularly in the subjects of science and technology, which are most relevant to environmental issues.

Table 5.9: Building a bridge between students and society

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
14	Primary school students need an awareness and understanding of the interaction between technology and society.	10 45.5%	12 54.5%	0 0%	0 0%	0 0%
15	It is important for students to recognize the environmental issues caused by technological developments.	10 45.5%	11 50%	1 4.5%	0 0%	0 0%

Table 5.10 represents the findings for Statements 16 (“Current primary curricula can help prepare students to be creative and innovative”) and 17 (“Current primary curricula can help prepare students to be technologically literate”). Overall, data in this table suggest that the majority of teachers do not believe that the current primary curricula enhance students’ technological literacy.

Nearly two-thirds of the teachers (63.6 percent) do not believe that current primary curricula can prepare students to be creative and innovative, while most of the remainder did agree with the statement and two expressed no opinion. There was an even higher level of disagreement with Statement 17; 16 of the 22 respondents (72.7 percent) disagreed although none strongly disagreed. In other words, there was general cynicism that the current primary Saudi curriculum was adequate to prepare students for further (secondary) technological education. Only four respondents believed it was adequate.

Table 5.10: Ability of current primary curricula to enhance students’ technological literacy

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
16	Current primary curricula can help prepare students to be creative and innovative.	1 4.5%	5 22.7%	2 9.1%	13 59.1%	1 4.5%
17	Current primary curricula can help prepare students to be technologically literate.	1 4.5%	3 13.6%	2 9.1%	16 72.7%	0 0%

Table 5.11 represents the findings of Statements 18 (“The current developed science curricula for primary schools can help prepare students to be creative and innovative”), 19 (“The current developed science curricula for primary schools can help prepare students to be technologically literate”), and 20 (“The current developed science curricula for primary schools include several technological topics”). There was substantial disagreement with Statements 19 and 20, but there was more variation than with regard to other statements: 72.7 percent of respondents felt that creative or innovative students would not be assisted by the current developed science curricula, and 68.2 percent felt that students who are technologically literate would not be advantaged by the present curricula. Fourteen respondents (63.6 percent) disagreed with Statement 20 and only five either agreed or strongly agreed with such a proposition. Generally, teachers’ perceptions reveal that more attention should be given to including technology education that would improve current science and technology curriculum in order to enhance students’ technological literacy.

Table 5.11: Ability of current developed science and technology curricula to enhance students' technological literacy

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
18	The current developed science curricula for primary schools can help prepare students who are creative and innovative.	2 9.1%	1 4.5%	3 13.6%	16 72.7%	0 0%
19	The current developed science curricula for primary schools can help prepare students who are technologically literate.	1 4.5%	4 18.2%	1 4.5%	15 68.2%	1 4.5%
20	The current developed science curricula for primary schools include several technological topics.	1 4.5%	4 18.2%	2 9.1%	14 63.6%	1 4.5%

Table 5.12 represents the findings of Statements 21 ("I find in myself the ability and the competence to teach technology in primary education"), 22 ("I comprehend the concept of technology in the current primary science curricula"), 23 ("I can distinguish between technology concepts and science concepts as subjects in the educational curricula"), and 24 ("I teach and help my students to design and produce simple technical products"). These statements concerned science teachers' self-assessments regarding their own abilities in

teaching technological subjects in primary school. Most were reasonably or very confident in their own abilities. A majority (59.1 percent) of the respondents either agreed or strongly agreed that they had the ability and the competence to teach technology in primary education. Three teachers expressed no opinion while six thought they lacked such ability and/or competence. Fifteen respondents (68.2 percent) felt they understood the concept of technology in the present primary education science curricula, while three expressed no opinion and four disagreed with that statement. An even higher proportion (81.8 percent) felt they could distinguish between the concepts of technology and science in the educational curricula, and only three felt they could not. Twelve teachers (54.5 percent) agreed with Statement 24, while the other 10 disagreed or expressed no opinion. Interestingly, this data indicates that more than half of the teachers responded positively to these statements, which means that those teachers are highly motivated to provide technology education and participate in further professional development to ensure they can teach this subject effectively. These positive respondents might require less training time than those who responded negatively to these statements.

Table 5.12: Science teachers' comprehension of technology education

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
21	I find in myself the ability and the competence to teach technology in primary education.	4 18.2%	9 40.9%	3 13.6%	6 27.3%	0 0%
22	I comprehend the concept of technology in the current primary science curricula.	7 31.8%	8 36.4%	3 13.6%	4 18.2%	0 0%
23	I can distinguish between technology concepts and	5	13	1	3	0

	science concepts as subjects in the educational curricula.	22.7%	59.1%	4.5%	13.6%	0%
24	I teach and help my students to design and produce simple technical products.	3 13.6%	9 40.9%	5 22.7%	5 22.7%	0 0%

5.10.2 Perceptions of tutors at technology colleges

Thirty-eight tutors at the Secondary Vocational Institute in Jeddah (17), Technology College in Jeddah (11), and Technology College in Makkah (10) completed the questionnaire. Each question was a statement to which the participants responded using a Likert scale; see Appendix 7.

All the statements in Table 5.13 reflect aspects that help tutors keep pace with and understand the impact of the technological revolution on Saudi curricula. There was almost total agreement (combined strong agreement and simple agreement) that the Government needs to review curricula as a response to the changes (94.8 percent agreement), and that students need to develop a wide range of technological literacy understanding (97.4 percent). The vast majority (86.8 percent) also either agreed or strongly agreed that providing primary school pupils with technological knowledge will help them to keep pace with and understand technological change. Overall, this data suggests that the tutors were aware of the technological revolution and its influence on education. Thus, technological literacy should be taken into account when the Ministry of Education in Saudi Arabia assess curricula to reform education.

Table 5.13: Influence of the technological revolution on curricula

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The technological revolution requires governments to review curricula	18 47.4%	18 47.4%	2 5.3%	0 0%	0 0%
2	Students need to develop a wide range of technological literacy understanding.	27 71.1%	10 26.3%	1 2.6%	0 0%	0 0%
3	Providing primary school pupils with technological knowledge will help them to keep pace with and understand technological change.	17 44.7%	16 42.1%	5 13.2%	0 0%	0 0%

Table 5.14 reveals a significantly positive attitude towards all the positive aspects suggested therein. A vast majority (89.5 percent) of respondents agreed that including teaching technology in the primary curriculum will help develop pupils' capabilities to solve technological problems by applying scientific and mathematical ideas. Twenty-seven respondents (71.1 percent) agreed or strongly agreed with Statement 5 (that primary school pupils would benefit from learning about the design of technological products). For Statement 6 – that including teaching technology would offer hands-on learning that makes learning more fun – 94.8 percent of respondents agreed, while only two had no opinion. Finally, 27 respondents (70.1 percent) also showed a considerable positive attitude towards Statement 7, which stated that without such an understanding of

technology, students may feel powerless and threatened; a further eight (21.1 percent) had no opinion and three (7.9 percent) disagreed with that statement.

Table 5.14: Positive aspects of including technology in the Saudi primary curriculum

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
4	Including teaching technology in the primary curriculum will help develop pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.	12 31.6%	22 57.9%	3 7.9%	1 2.6%	0 0%
5	Primary school pupils would benefit from learning about the design of technological products.	8 21.1%	19 50.0%	8 21.1%	3 7.9%	0 0%
6	Including teaching technology will offer hands-on learning that makes learning more fun.	18 47.4%	18 47.4%	2 5.3%	0 0%	0 0%
7	Without such an understanding of technology, students may feel powerless and threatened.	11 28.9%	16 42.1%	8 21.1%	3 7.9%	0 0%

Table 5.15 included four suggested benefits of teaching technology to Saudi society and economy. Overall, there was a strong consensus (over 84 percent) regarding all of the benefits listed in this table. As many as 92.1 percent of respondents agreed that including technology in the Saudi primary curriculum would help develop primary schools pupils' awareness and understanding of the interaction between technology and society. Statement 9 proposed that including teaching technology in the curriculum would help develop primary pupils' awareness of their responsibility towards environmental issues caused by technological development. This statement received significant agreement from 33 respondents (86.8 percent), while the other five (13.2 percent) had no opinion. Thirty-two respondents (84.2 percent) either agreed or strongly agreed that including teaching technology in the curriculum would help develop primary school pupils' appreciation of the importance of technology to Saudi Arabia's economic development. A small minority (six respondents, or 15.8 percent) had no opinion. Finally, 36 of the 38 respondents (94.8 percent) either agreed or strongly agreed that Saudi Arabia could benefit from a greater number of technologists. Two respondents (5.3 percent) took a neutral opinion.

Table 5.15: Benefits of teaching Technology to Saudi society and economy

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
8	Including technology in the Saudi primary curriculum will help develop primary schools pupils' awareness and understanding of the interaction between technology and society.	15 39.5%	20 52.6%	3 7.9%	0 0%	0 0%
9	Including teaching technology in the curriculum will help	10 26.3%	23 60.5%	5 13.2%	0 0%	0 0%

	develop primary pupils' awareness of their responsibility towards environmental issues caused by technological development.					
10	Including teaching technology in the curriculum will help develop primary school pupils' appreciation of the importance of technology to Saudi's economic development.	11 28.9%	21 55.3%	6 15.8%	0 0%	0 0%
11	Saudi Arabia could benefit from a greater number of technologists.	24 63.2%	12 31.6%	2 5.3%	0 0%	0 0%

This theme (Table 5.16) reflects the optimistic perceptions of the respondents concerning primary education as a foundation for further technology learning. Thirty-two of 38 respondents (84.2 percent) agreed that including teaching technology in the Saudi primary curriculum would support teaching technology in universities, technology colleges and technical vocational training institutes. A small minority either had no opinion (13.2 percent) or disagreed (2.6 percent). Almost all of the respondents (89.4 percent) either agreed or strongly agreed that including teaching technology in the primary curriculum will help pupils leave this stage have acquired sufficient basic skills in technology. Opinions regarding Statements 13 and 14 were identical. In both cases 89.5 percent either agreed or strongly agreed, while 7.9 percent had no opinion and one respondent (2.6 percent) disagreed. Overall, the participants were highly positive about teaching

technology education in primary education, and felt that this would equip students with knowledge and skills that they need for further technology learning.

Table 5.16: Technology in primary schools as a foundation for further technology learning

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
12	Including teaching technology in the Saudi primary curriculum will support teaching technology in universities, technology colleges, and technical vocational training institutes.	22 57.9%	10 26.3%	5 13.2%	1 2.6%	0 0%
13	Including teaching technology in the primary curriculum will help pupils leave this stage having acquired sufficient basic skills in technology.	14 36.9%	20 52.6%	3 7.9%	1 2.6%	0 0%
14	Including teaching technology in primary schools will help pupils identify professional capabilities.	15 39.5%	19 50.0%	3 7.9%	1 2.6%	0 0%

Table 5.17 covers the final proposition of the questionnaire and explores respondents' perceptions towards technology in primary schools. The statement was about the relationship between science and technology. There was complete agreement among the respondents that science and technology are complementary to each other, which shows that all participants understand the nature of the relationship between science and technology.

Table 5.17: The relationship between science and technology

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
15	Science and technology are complementary to each other	21 55.3%	17 44.7%	0 0%	0 0%	0 0%

5.10.3 Perceptions of technology advisors at technology council in Makkah

The 22 participants in this study work at the Technology Council in Makkah Region. Their role is to supervise all technological activities within the region, including helping students to find the appropriate jobs after they graduate. Each question was a statement to which the participants responded using the Likert scale; see Appendix 8.

The statements in Table 5.18 were: 1 ("The technological revolution of the 21st century requires governments to review curricula"), 2 ("Students need to develop a wide range of technological literacy understanding") and 3 ("providing primary school pupils with technological knowledge will help them to keep pace with and understand technological change"). These statements reflect perceptions of technology advisors towards the impact of the technological revolution on the curricula. The vast majority of respondents (20 out of 22, or 90.9 percent) agreed that the government needs to review curricula as a response to the technological revolution. All but one respondent agreed that students need to develop a wide range of technological literacy understanding; the other respondent

disagreed. All respondents agreed with Statement 3. Overall, this data suggests that technology advisors are aware of the technological revolution and its impact on curricula. This impact requires Saudi Arabia government to review curricula that prepare students to understand technology and the technological changes in the world.

Table 5.18: The technological revolution and curricula

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The technological revolution requires governments to review curricula.	11 50.0%	9 40.9%	0 0.0%	2 9.1%	0 0.0%
2	Students need to develop a wide range of technological literacy understanding.	17 77.3%	4 18.2%	0 0.0%	0 0.0%	1 4.5%
3	Providing primary school pupils with technological knowledge will help them keep pace with and understand technological change.	17 77.3%	5 22.7%	0 0.0%	0 0.0%	0 0.0%

The theme in Table 5.19 is positive aspects of including technology in the Saudi primary curriculum. There was a significantly positive attitude towards all positive aspects suggested in this table. Twenty (68.2 percent) of the respondents agreed that including teaching technology in the primary curriculum would help pupils' capabilities to solve

technological problems by applying scientific and mathematical ideas. A small minority had no opinion or disagreed (18.2 percent and 13.6 percent, respectively). To Statement 5, suggesting that primary school pupils would benefit from their learning of designing technological products, 19 respondents (or 86.3 percent) agreed or strongly agreed while two (9.1 percent) had no opinion and one disagreed. The greatest agreement was towards Statement 6; 90.9 percent agreed that including teaching technology would offer hands-on learning that makes learning more fun. Lastly, 14 respondents (62.6 percent) indicated a positive attitude towards Statement 7; two (9.1 percent) either had no opinion or strongly disagreed and four (18.2 percent) disagreed.

Table 5.19: Positive aspects of including technology in the Saudi primary curriculum

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
4	Including teaching technology in the primary curriculum will help develop pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.	10 45.5%	5 22.7%	4 18.2%	3 13.6%	0 0.0%
5	Primary school pupils would benefit from learning about the design of technological products.	7 31.8%	12 54.5%	2 9.1%	1 4.5%	0 0.0%
6	Including teaching technology will offer hands-on learning that makes learning more fun.	13 59.1%	7 31.8%	1 4.5%	1 4.5%	0 0.0%

7	Without such an understanding of technology, students may feel powerless and threatened.	5 22.7%	9 40.9%	2 9.1%	4 18.2%	2 9.1%
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Table 5.20 includes four suggested benefits of teaching technology to Saudi society and the economy. There were highly positive attitudes among the respondents towards all the benefits listed in this block. Nearly two-thirds (63.6 percent) of the respondents either agreed or strongly agreed that including technology in the Saudi primary curriculum would help primary schools pupils' awareness and understanding of the interaction between technology and society. Only one respondent (4.5 percent) expressed a neutral opinion and one other (4.5 percent) expressed simple disagreement. Statement 9 proposed that including teaching technology in the curriculum would help develop primary pupils' awareness of their responsibility towards environmental issues caused by technological development. This statement received significant support from a great number of the respondents (17, or 77.3 percent); only three (13.6 percent) had no opinion and two (9.1 percent) disagreed. In addition, 15 respondents (68.2 percent) either agreed or strongly agreed that including teaching technology in the curriculum would help develop primary school pupils' appreciation of the importance of technology to Saudi Arabia's economic development. A small minority of respondents (six, or 27.3 percent) had no opinion and one (4.5 percent) disagreed. Finally, 21 of the 22 respondents (95.5 percent) either agreed or strongly agreed that Saudi Arabia could benefit from a greater number of technologists. One respondent (4.5 percent) reported a neutral opinion.

Table 5.20: Benefits of teaching technology to Saudi society and economy

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
8	Including technology in the Saudi primary curriculum will help develop primary school pupils' awareness and understanding of the interaction between technology and society.	14 63.6%	6 27.3%	1 4.5%	1 4.5%	0 0.0%
9	Including teaching technology in the curriculum will help develop primary pupils' awareness of their responsibility towards environmental issues caused by technological development.	8 36.4%	9 40.9%	3 13.6%	2 9.1%	0 0.0%
10	Including teaching technology in the curriculum will help develop primary school pupils' appreciation of the importance of technology to Saudi Arabia's economic development.	8 36.4%	7 31.8%	6 27.3%	1 4.5%	0 0.0%

11	Saudi Arabia could benefit from a greater number of technologists.	16 72.7%	5 22.7%	1 4.5%	0 0.0%	0 0.0%
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Table 5.21 reflects optimistic perceptions of the respondents concerning primary education as the foundation for further technology learning. Twenty-one of the 22 respondents (95.5 percent) agreed or strongly agreed that including teaching technology in the Saudi primary curriculum would support teaching technology in universities, technology colleges and technical vocational training institutes, while only one disagreed (4.5 percent). Nineteen respondents (86.3 percent) either agreed or strongly agreed that including teaching technology in the primary curriculum would help pupils to leave this stage having acquired sufficient basic skills in technology. A small minority either had no opinion or disagreed (9.1 and 1.1 percent, respectively). A total of 90.9 percent either simply agreed or strongly agreed that including teaching technology in the primary curriculum would help pupils acquire enough basic skills in technology and would also help discover pupils' professional capabilities; 4.5 percent had no opinion and 4.5 percent disagreed with that statement. Overall, the participants were highly positive towards the teaching of technology education in primary education, which they felt would help equip students with knowledge and skills that they need for further technology learning.

Table 5.21: Technology in primary schools as a foundation for further technology learning

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
12	Including teaching technology in the Saudi primary curriculum will support teaching technology in universities, technology colleges, and technical	14 63.6%	7 31.8%	0 0.0%	1 4.5%	0 0.0%

	vocational training institutes.					
13	Including teaching technology in the primary curriculum will help pupils leave this stage having acquired enough basic skills in technology.	14 63.6%	5 22.7%	2 9.1%	1 1.1%	0 0.0%
14	Including teaching technology in primary schools will help identify pupils' professional capabilities.	16 72.7%	4 18.2%	1 4.5%	1 4.5%	0 0.0%

Table 5.22 covers the final proposition of the questionnaire and explores perceptions of the respondents towards technology in primary schools. The statement concerned the relationship between science and technology. There was almost total agreement among the respondents that science and technology are complementary to each other (91 percent). Only one respondent had a neutral opinion and one other respondent simply disagreed. This data suggests that all participants understand the nature of the relationship between science and technology

Table 5.22: The relationship between science and technology

No	Statement	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
15	Science and technology are complementary to each other	10 45.5%	10 45.5%	1 4.5%	1 4.5%	0 0.0%

5.11 Findings From Open-Ended Questions

Thirty-eight tutors at technology and vocational institutes and technology colleges, 22 technology advisors and 22 science teachers were asked the following questions to further explore their perceptions about teaching technology in primary schools.

- 1- Do you think technological literacy can be developed within existing primary curricula? Please comment.
- 2- Do you think technology can be taught as a separate subject or integrated with other subjects? Please comment.
- 3- What are the most important aspects of technological literacy?

From these questions, the following themes were generated for each group and the findings from each group are discussed under separate headings.

5.11.1 Science Teachers' perceptions of technology education

5-11-1 -1 Emerging theme 1: The existing curricula do not help to develop technological literacy

Eighteen of the 22 teachers who participated in this survey had negative perceptions of the following statement: "Technological literacy can be developed within the current curricula." They gave three main reasons. Firstly, the current curricula mostly are theory-based. Seven participants indicated that they do not expect that technological literacy can be developed within the current curricula because the education system fosters theory more than practice. The second reason related to an ill-defined concept of technology education within the curriculum. Six participants explained that no positive improvement would occur in terms of teaching technology within science because the concept of technology education has been ill-defined and the Ministry of Education should redefine it to make it clear for both students and teachers. The third reason is related to imbalanced content between science and technology. For instance, five participants indicated that there are some technological topics, but that these topics are insufficient to teach students about technology.

In contrast, two respondents had a positive perception regarding the statement that "Technological literacy can be developed within the current curricula." They believe that

science does have some technological topics and the teachers should employ them to support teaching technology.

5.11.1.2 Emerging theme 2: The appropriate method for including technology in the curricula

Eight participants believed that technology education should be integrated with other subjects. Two main reasons for this were identified. Three participants indicated that one of the reasons is to avoid a crowded curriculum, while the other participants indicated that science and technology are interwoven subjects, which means that technology can be integrated with science. However, they said this method needs qualified teachers who can deliver the two concepts to their students, so they really want to see a framework that would help teachers to do so. Other participants responded that technology should be included in curricula without providing a reason.

In contrast, 12 teachers believed that technology education should be a separate subject. Four participants felt that teaching technology separately would increase students' comprehension of technology. Another reason concerned the uniqueness of technology education. Two participants emphasized that technology education has special aspects such as mechanics, electricity and design that are important in today's education. Three participants thought this subject should be taught separately because it offers hands-on learning. One participant said, "[Technology] should be integrated at the beginning, then it can be taught as a separate subject at Years 5 and 6." Other participants were positive towards teaching technology separately without justifying their responses.

5.11.1.3 Emerging theme 3: Key aspects of technological literacy

The participants were asked to declare the aspects of technological literacy they considered to be the ultimate goal of teaching technology. They articulated some of the important aspects of teaching technology that aim to develop students' technological literacy and mentioned a variety of aspects to including technology in the curricula. Three participants indicated that improving education is one of the key aspects of technological literacy, bringing a modern subject to our curriculum such as technology education. Also, teaching technology will help make learning more fun and enjoyable by reducing the amount of conventional education that only focuses on the lecture style. Four participants indicated

that technology education helps to prepare students who are creative and innovative learners. These participants provided some positive aspects of teaching technology that helps students work in the technology and industry fields. Teaching Technology is also beneficial in helping students understand principals and ideas on which technological applications are based and how products are manufactured. Teaching Technology also allows students to become more confident when working with technology, as well as providing them with skills in which they can use to develop innovative products. Three participants revealed that teaching technology enhances students' technological literacy by developing their practical skills and providing them with tools that develop their skills in technology. Five participants believe that teaching technology pushes students to change their traditional thinking. Two participants mentioned that improving students' technological literacy through teaching this subject can help prepare students to be involved in future learning at technology colleges and engineering colleges. Three participants indicated that technology education is the best subject in terms of offering problem-solving skills for students and it will encourage students' thinking to evolve from traditional thinking to technological thinking. Two participants did not respond to this question.

5.11.2 Technology advisors' perceptions of technology education

5.11.2.1 Emerging theme 1: Developing technological literacy within the existing curricula

Eighteen of 22 participants had negative perceptions of the following statement: "Technological literacy can be developed within the current curricula." They gave three main reasons for these perceptions. Firstly, the current curricula do not support the entire concept of technology education. One participant said that while there are some technological elements included within science, they do not relate directly to technology. Secondly, the education system in Saudi focuses on theory rather than practice. Four participants indicated that the current curricula do not assist to develop students' technological literacy because they are theory-based curricula that do not focus on technology as a practical topic. The third reason was that the concept of technology education is still vague among teachers. Two participants said that the concept of technology has not been clearly defined in the Saudi curricula, so the Ministry of

Education should work to identify it in order to help students to learn about this modern subject.

No participants believed that technology can be developed within the current curricula. Three participants did not respond to this question, while one participant disagreed with the idea of teaching technology in primary schools because he felt the main message at that stage should be literacy and numeracy.

5.11.2.2 Emerging theme 2: The appropriate method of including technology in the curricula

Three participants believed that technology education should be integrated with other subjects. One justified his position by saying students would not feel bored; also because technology is part of all other subjects and we cannot separate it. Another participant explained that integrating technology with other subjects can help to avoid the issue of crowded curricula.

Ten participants believed that technology education should be taught as a separate subject, for two main reasons. Three participants indicated that separating the subjects would help students to spend enough time learning about technology and give them the opportunity to practise these skills. Two participants explained that separation helps to emphasise the importance of technology.

One participant believed it would not be a major issue if technology was taught either separately or integrated, but he did want to see it in primary education. He said, “It can be done in either way after making a good plan to teach it.”

Another participant argued that technology should not be included at all in primary education. He said, “It should not be taught in primary schools. However, the teachers can talk about it as general information across other subjects.” Another participant agreed but made it clear that it should be taught later. He said, “It should be taught at intermediate and high schools, not as a separate subject but it should be integrated with other scientific subjects such as general science, chemistry and physics.”

5.11.2.3 Emerging theme 3: Key aspects of technological literacy

These 22 technology advisors were asked to declare which aspects of technological literacy they considered to be the ultimate goal in teaching technology. They articulated some of the important aspects of teaching technology that aim to develop students' technological literacy. The participants provided a variety of aspects related to including technology in the curricula

Two participants felt that the fact that including technology in the curricula would improve students' technological literacy was a key aspect. Several responses reflected this aspect, such as introducing practical aspects in education, disseminating technology culture in society, and helping students to learn what is happening in the world about technology. Shifting education from traditional classes to practical classes was another key aspect. Three participants felt that teaching technology would help to shift education from traditional classes to practical classless. Three participants indicated that teaching technology would help students understand industrial life; teachers could take them to visit some factories to see how products such as food and machines are processed, and that this would provide a great opportunity to inspire students to work in these factories. Further, four participants indicated that teaching technology can help students understand some approaches to solving technological problems, and students can also design possible solutions to some technological problems. Three participants revealed three key aspects of technological literacy: teaching technology will create a generation that can easily understand technology and deal with it; it offers hands-on learning; and students need awareness of everyday technologies. Two participants indicated that this subject would offer computing literacy and industrial literacy. Three participants linked the importance of technology with environment and society; he said that teaching technology would increase students' awareness of the impact of technology on the environment. Two participants responded that understanding the international language of technology is one of the key aspects of technological literacy.

5-11-3 Tutors' perceptions of technology education

5-11-3-1 Emerging theme 1: Developing technological literacy within the existing curricula

Nineteen out of 38 participants had negative perceptions of this statement: "Technological literacy can be developed within the current curricula." They provided two main reasons. Firstly, teaching in Saudi schools is based on conventional methods. For example, 15 participants agreed that Literacy in Saudi Arabia is only about teaching, writing and reading by applying conventional methods and also using retaining or repetition without any development of the ability, thinking and technical skills of students." Four participants mentioned technology needs practice but the pedagogy in our schools focus on conventional teaching methods." Secondly, curricula – especially science – do not include enough topics about technology education. For instance, 17 participants felt, "The current curricula do not support the technological topics or even encourage students to know about technology."

In contrast, six participants had positive perceptions of the same statement: "Technological literacy can be developed within the current curricula". They felt that technology is linked with computers and mobile phones that are available in schools. For instance, two participants said, "We can see that our students have been significantly using technology such as computers and mobile [phones]." Other participants provided short answers without further explanations; five simply said "Yes" and eight responded "No".

5-11-3-2 Emerging theme 2: The appropriate method of including technology in the curricula

Integrating technology education with other subjects was supported by 14 participants who had a positive perception about this idea. The findings show that two key factors inspired the participants to believe that integration is a suitable way to include technology education on the curriculum. The first factor was the complementarity between science and technology. Four participants indicated that if it is integrated with science it would be much better, because science and technology are complementary to each other. Three participants indicated that technology should be integrated with other subjects because subjects in primary school are interwoven and it is not appropriate to teach each subject

separately. The second factor was related to the issue of crowded curricula. For example, one participant explained that integrating technology with other subjects helps to avoid crowded curricula, which create pressure on students. Another participant indicated that because the concept of the correlated curriculum is important in primary schools, fewer subjects with a high quality of learning and knowledge are preferable.

In contrast, 15 participants had positive perceptions about teaching technology education as a separate subject. The participants identified some reasons that led them to hold this position. For example, they considered technology to be a unique subject that has positive aspects that should be addressed separately. One participant mentioned that teaching technology separately would be more effective because its positive aspects will not be recognised and measured properly if it is integrated with other subjects. Another reason for teaching technology separately was that it allowed students to focus more on this subject by including a specific time for technology in the timetable. One participant said that it should be taught separately in order to give students the opportunity to have more focus on learning this subject. In addition, there was a sense that any imbalance of technology content would be avoided if it was not integrated with other subjects. For instance, a participant indicated that it would be useful to teach it separately to avoid any imbalance between technology and the subject it is integrated with.

Eight participants felt that it would not be a big issue if technology was taught either separately or integrated, but they did want it taught in primary education. They emphasized the importance of teaching design. For instance, one participant suggested that the Ministry of Education should involve technical and vocational training cooperation to design the content. He also made the following suggestions: (1) The subject should be divided into parts, with one part focusing on science (Term 1) and the other focusing on technology (Term 2). (2) Students should be permitted to visit exhibitions, factories and technical institutes. (3) The subject could be implemented step by step; for example, by integrating it with science and, when the teachers become familiar with teaching technology, teaching it separately. Another participant commented that, when technology is taught at primary schools, there is no major difference between whether it is taught separately or with other subjects; the important thing is that the teachers should clearly identify the content of technology in the classroom.

5-11-3-3 Emerging theme 3: Key aspects of technological literacy

The participants were asked to identify which aspects of technological literacy they considered to be the ultimate goal in teaching technology.

Twenty-two of the 38 participants were able to discuss some of the important aspects in teaching technology that aim to develop students' technological literacy. The participants felt that creating a technical generation was one of the key aspects. In fact, several responses reflected this aspect, such as producing a technical generation that uses and makes technology effective, producing a technological community, and spreading the technological concept in homes and the community in general. Improving students' technological literacy was another key aspect. Two participants felt that teaching technology would help to improve students' technological literacy, while another indicated that adding a new method in teaching (innovative method) is a key aspect of teaching technology as it helps to improve students' innovative and creative skills. Similarly, another participant explained that teaching technology improves students' creative skills that help them to design products. Helping students to love technology and encouraging them to be technologists in the future was also one of the key aspects of teaching technology, according to two participants.

5-12 Summary

Table 5.25 below summarises the findings of this study in terms of the situation of technology education at the primary school level in New Zealand and Saudi Arabia. Ten aspects of technology education were investigated and compared in order to have a better understanding of this subject in both contexts and also to inform the Saudi context. These aspects are: (1) Topic title; (2) Where does science and technology sit in the curricula? (3) Rationale for teaching technology education; (4) Definition; (5) Structure; (6) Technology education in the educational policy; (7) Content; (8) Implementation; (9) Teachers' efficiency, and (10) Learning outcome.

1- Topic title

It can be seen from the comparison that 'technology education' is the title of this subject in New Zealand and 'science and technology' in Saudi Arabia.

2- Position of the subject in the curricula

The comparison shows that technology education has been taught in New Zealand as a distinct subject, while in Saudi Arabia it has been taught with science. The data suggest that different implementation of technology education has led to different learning outcomes.

3- Rationale for teaching technology education

There is quite a strong similarity in terms of the rationale for teaching technology education in the two countries. The national curricula of the two nations indicate that technology education provides students with thinking and practical skills. In New Zealand, the rationale was more specific in that teaching technology education aims to develop broad technological literacy that will equip students in order for them to participate in society as informed citizens. In Saudi Arabia, the rationale intends to help students to link science and technology with other disciplines such as mathematics, arts, health and society, while in New Zealand the intention is to help students to learn about technology as an independent field of human activity.

4- Definition

The New Zealand national curriculum provides a clear definition of technology education that is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes). In contrast, there is no evidence that this subject has been defined in the Saudi national curriculum, except for the definition given by one of the curriculum experts who teaches in one of the Saudi Universities. He defined technology education as, “A discipline that focuses on teaching technology as a human activity including control systems and their basic elements, which include tools, materials, knowledge, skills, people, power, time and funding” (Fath-Allah, 2006). This definition might be considered by teachers who want to improve their ability to teach technology to their students in the absence of the attention of the Ministry of Education towards technology education.

5- Structure

Having a definition of technology education appears to have impacted the structure of technology education in the national curricula in New Zealand and Saudi Arabia. The curriculum developers in New Zealand suggest a framework for teaching technology education that comprises three strands that form the technology education concept – technological practice, technological knowledge, and nature of technology – each of which has specific components that reflect the strand. The New Zealand framework also includes five technology areas: biotechnology, food, control, ICT, and structural. In Saudi Arabia, the subject has no specific structure but there are two main aspects – scientific knowledge and practical skills in science and technology – that were focused on in the introduction of the textbook of science subjects that and reflect the entire philosophy of science and technology.

6- Technology education in educational policy

Technology education has been addressed by the educational policy in both contexts. In New Zealand, technology is one of the national goals of education (NAG). NAG 1-5 states that priority should be given to the development of high levels of competence (knowledge and skills) in science and technology with other essential learning areas. The educational policy in Saudi Arabia states: (1) knowledge and technology is a means to develop the country in different aspects and will help the country catch up with other advanced countries; (2) schools should offer scientific and technological skills to allow students to contribute to making products; (3) schools should allow students to study scientific principles and scientific thinking to help improve their creativity level, and (4) one of the primary education objectives is to help students appreciate practical works.

7- Content

The content of technology education is different in both contexts. In New Zealand, there is no specified content, but a syndicate of teachers at each school can decide what topics will be taught technology, using the New Zealand education curriculum as a guide. In Saudi Arabia, the Ministry of Education prints the required textbooks every year and sends them to the schools. Teachers must deliver these curricula without excluding any part of the content or including any other. The data from the present study suggest that the content

focuses on science rather than technology education. Also, it does not help students to develop technological design skills, understand the relationship between science and technology, or understand applications of technology.

8- Implementation

The technology education practice aspect was the most significant difference between technology education in New Zealand and Saudi Arabia. Technology was implemented in New Zealand using a variety of pedagogical methods in the classroom, including problem-based learning, enquiry learning, discussion, individual learning and collaborative learning. These methods provided pupils with opportunities to help them use thinking skills in learning. Materials were available and related to the topics. However, there were issues that could affect students' technology education learning outcomes. The first issue is that teachers did not give more opportunities to talented and gifted students to deal with additional challenges equivalent to their thinking and skills. The second issue is related to gender bias: the teachers did not consider this issue in the classroom, which could have an impact on students' learning.

In Saudi Arabia, technology education is implemented using a penta-method that goes through five learning steps: preparation, investigation and exploration, explanation and interpretation, enriching, and expansion. Limited pedagogical methods were implemented in the classrooms, with lecture style and discussions dominating. Teaching materials were available and were related to the topics.

9- Teachers' efficiency

The findings show that there was a difference in terms of New Zealand and Saudi teachers' efficiency. Teacher in New Zealand were able to:

- Support students by providing a range of appropriate resources to select from
- Guide students to identify the attributes and an appropriate outcome
- Support students to evaluate outcomes
- Support students by establishing an environment that encourages and supports student innovation when generating design ideas

- Provide opportunities for students to develop skills required to produce their outcomes.

However, both New Zealand teachers had a narrow view of implementing technology, as evidenced by the fact that the teacher in Year 2 focused on the technology practice strand only, while the teacher in Year 6 focused on the technological knowledge strand. Neither teacher taught all three strands of technology in the New Zealand curriculum, as recommended by expert Kate. Kate explained that teaching all three strands is important because the teaching of technology education in New Zealand is based on a broad concept of technological literacy rather than a narrow concept of just making or knowing.

Teachers in Saudi did not appear to be prepared to teach technology and they needed to cover a tightly-packed curriculum. They skipped any practical tasks to complete teaching the subject within the specified time. However, on some occasions they provided an opportunity for students to think about questions before giving an answer.

10- Learning outcomes

The data suggest that different technology education philosophies in New Zealand and Saudi Arabia led to different learning outcomes. The study found that students in New Zealand:

- Were involved in authentic activities
- Became familiar with some technological terms
- Learned how to negotiate the design with the teacher and among each other by identifying the attributes and an appropriate outcome of the product
- Were able to identify the resources and the materials they needed to make the product
- Solved given problems by thinking about the solution, thinking about the materials, and drawing their suggested solution on a sheet
- Were able to evaluate outcomes in keeping with the attributes
- Described the properties used to make the product.

Students in Saudi Arabia:

- Were involved in authentic activities

- Became familiar with some scientific terms
- Learned how to negotiate environmental issues based on scientific facts
- Discussed some positive and negative impacts of energy on the environment and ways of protecting it.

Table 5.23: Comparison of technology education at primary school level in New Zealand and Saudi Arabia

New Zealand	Saudi Arabia
Aspects of comparison	
Topic title	
Technology education	Science and technology
Where does it sit in the curricula?	
A separate subject	Integrated with science
Rationale for teaching technology education	
<p>The aim is for students to:</p> <ul style="list-style-type: none"> - Develop a broad technological literacy - Learn practical skills - Learn technology as a field of human activity 	<p>The aim is for students to:</p> <ul style="list-style-type: none"> - Learn practical methodology - Learn thinking and practical skills - Link science and technology with other disciplines
Definition	
Technology is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes).	A discipline that focuses on teaching technology as a human activity including control systems and their basic elements, which include tools, materials, knowledge,

	skills, people, power, time and funding (Fath-Allah, 2006).
Structure	
<ul style="list-style-type: none"> - Technological practice, technological knowledge and nature of technology - There are five areas of technology (biotechnology, food, control, ICT, and structural) 	Scientific knowledge and practical skills in science and technology
Technology education in the educational policy	
Priority should be given to science and technology with other essential learning areas	<ul style="list-style-type: none"> - Developing the country in different aspects such as economic, social, health and environment aspects - Teaching scientific, technological, thinking, and creative skills.
Content	
There is a guideline to teach areas of technology based on these domains: technological practice, technological knowledge, and nature of technology	The content focuses on science rather than technology education
Implementation	
<ul style="list-style-type: none"> - Technology education achievements (Table 5.1) - A variety of pedagogical methods 	<ul style="list-style-type: none"> - Using a penta-method to teach science and technology - Limited pedagogical method implemented in the classrooms

<p>implemented in the classroom</p> <ul style="list-style-type: none"> - Using thinking skills in learning - Materials were available and related to the topics - Talented and gifted students; and gender bias issues. 	<ul style="list-style-type: none"> - The lesson plan and the method of teaching were significantly relevant to science - Materials were available and were related to the topics
Teachers' efficiency	
<ul style="list-style-type: none"> - Teachers supported and guided students to learn in an instructive approach but they had a narrow view of implementing technology education 	<p>The teachers did not appear to be prepared to teach technology.</p>
Learning outcomes	
<ul style="list-style-type: none"> - Involved students in authentic activities - Used a variety of technological terms - Negotiated the design - Identified the resources - Used problem solving - Evaluated outcomes - Described the properties 	<ul style="list-style-type: none"> - Involved students in authentic activities - Used some scientific terms - Learnt about energy and its types, ways of saving it and its impact on the environment

5-13 Conclusions

The findings in this study, obtained from document analysis, classroom observation, and interviews, suggest that there are some similarities and differences between technology education in New Zealand and Saudi Arabia. There is an emphasis on teaching technology in the policy of education in both contexts and the majority of participants agree that technology education is an essential subject that can improve students' technological literacy.

The data shows that the difference was significantly associated with the practice, where technology education was taught differently in classrooms in both contexts.

In New Zealand teachers were provided with guidelines that explain technology education goal and objectives of technology education that help teachers to implement this subject with the aim of improving students' technological literacy.

In Saudi Arabia, by contrast, the findings imply many problems and challenges face teaching technology education in primary education including vague interpretation of science and technology in the educational policy. These problems disqualified teachers who were not able to understand the boundaries between science and technology, which resulted in poor implementation of technology education in the classroom. Moreover, the findings suggest that current curricula in general and developed science and technology curricula in primary education do not help to improve students' technological literacy and the participants in the Saudi Arabia study claimed that technology education must be clearly defined and included in the curricula either integrated with science or as a separated subject. Consequently, there is a need to review science and technology curriculum in Saudi Arabia to cope with the current concept of technology education that has been introduced in countries such as New Zealand. The review must also include the educational policy and re-training teachers by involving them in a further professional development that enables them to implement technology in the classroom based on the development steps that must be identified as a proposal to develop science and technology curriculum.

Chapter 6

Discussion, Implications, Limitations, Recommendations and Conclusions

6.0 Introduction

This chapter discusses the present study's findings in light of the relevant literature. It also covers the study's contexts, phases and to answer the key research question as a primary objective of this study: How can the experience of New Zealand's implementation of technology education inform technology education in the Saudi curriculum?. The structure consists of nine key elements (listed below) that give the reader a summary of the most important points in the thesis and discuss the major findings from chapter 5 and interpreting them along with the literature; this will help to answer the research questions. Implications and recommendations, study limitation, direction for further research, and conclusion also will be discussed.

- 1- Key research findings
- 2- Implementing Technology Education in New Zealand and Saudi Arabia
- 3- Findings Gained from Interviews with Technology Education Teachers in New Zealand and Saudi Arabia
- 4- Findings from Interviews with Technology Experts in New Zealand and Saudi Arabia
- 5- Findings Gained from Survey Participants in Saudi Arabia
- 6- Principal Implications and Recommendations of Research Findings
- 7- Study Limitations
- 8- Directions for Further Research
- 9- Conclusion

6.1 Key Research Findings

The findings in this study, obtained from documentary analysis, classroom observation and interviews, indicate that technology education was implemented as an independent subject in the New Zealand curriculum. The national curriculum inspires schools to teach technology education as a separate subject and I submit that schools should consider teaching technology education as it would strengthen students' knowledge of technology education. However, some schools might have a different strategy to provide technology education based on the vision of these schools towards that subject.

I can conclude that the primary school I observed has made good progress in implementing technology education, this conclusion is based on my classroom observations. The general goal of this subject is to improve students' technological literacy. The Ministry of Education provides technology education teachers with guidelines that help them teach technology education in the classroom. However, the findings of the present study have highlighted certain issues that could affect technology education in New Zealand. The first issue is that the school in this study did not cater to gifted and talented technology students. Some gifted and talented students had good prior knowledge and showed exceptional ability and commitment to finish the models given by the teachers; however, those students were not encouraged by the teachers, for example, through praise and giving them other advanced models to work on. Acknowledging and encouraging those students would develop their strengths and abilities (Ministry of Education, 2001). Gender bias was another issue that this school did not take into account. The reason for this bias needs to be explored because technology is presently a gendered subject that is generally associated with males (Lewis, 1999). The literature suggests that girls do not use construction and mechanical toys as often as boys do (Brown, 1993). Also, Spear's (1985) research into teachers' attitudes toward gender and technology showed that 49 percent of teachers thought that technical subjects are important for a boy's education, compared with only 24 percent for girls (cited in Cole & Conlon, 1994). The current study indicates that the teachers provided both male and female students with construction and technical activities, without giving them the choice to select which activities they preferred. Gender issue is a common issue that should be addressed and integrated into diverse international studies and curriculum (Rosenfelt, 1998). Thus, the Saudi curriculum, like other international curricula, must consider this issue to achieve equity and quality education for both genders. The current work does not provide any

explanation of this issue because education in Saudi Arabia is segregated and this study was only conducted in boys' schools.

The last issue is that the teachers at the school in New Zealand had a narrow view of implementing technology education in the classroom. The data shows that the teacher of Year Two focused only on the technological practice strand while the teacher of Year Six focused on the technological knowledge strand. Techlink (2008) indicated that technological practice strands on their own were not sufficient for developing students' technological literacy.

The findings also suggest that Saudi technology education teachers face several problems and challenges. First, in Saudi Arabia this subject has not been clearly defined and has been integrated with science subjects. I argue that the issue is not integrating technology with science, but the lack of a clear strategy that identifies the relationship between science and technology in order to introduce both subjects in an effective way; this issue was derived from the analysis of the official documents. Such a strategy should define science and technology, identify objectives of each subject, suggest an appropriate pedagogy to teach them, and consider professional development of technology teachers and how it is carried out. This study indicates that the Ministry of Education in New Zealand has partially addressed these elements that contributed to the development of teaching technology education. I believe that the issue of poor implementation of technology education in the Saudi classroom can be attributed to the vague interpretation of science and technology in the educational policy, and unqualified teachers who were not able to understand the boundaries between science and technology. Moreover, the findings, obtained from questionnaires answered by science teachers, technology tutors and technology advisors, suggest that the majority of the respondents believe that the current curricula in general, and developed science and technology curricula in primary education, do not help to improve students' technological literacy. The participants in this study claimed that technology education must be clearly defined and included in the curricula, whether integrated with science or as a separate subject.

This study found that the major difference between technology education in New Zealand and Saudi Arabia was associated with practice. This study provides evidence that the two subjects are taught differently in the two contexts by using different pedagogies based on

data collected from classroom observations in New Zealand and Saudi Arabia. The researcher observed that New Zealand teachers used a variety of teaching methods, such as problem-based learning, enquiry learning, discussion, designing, and student-self assessment, which reflect the processes of teaching and learning in the classroom, these teaching methods reported in the literature among the effective teaching and learning strategies suggested by Gray and Smith (1998). In contrast, the Saudi teachers used such conventional teaching methods as discussion and lecture-style techniques to teach students. I think the problem behind this issue is that, in Saudi Arabia, the Ministry of Education imposes the curricula and requires teachers to deliver contents of curricula to students during a specific time. This prevents teachers from using other teaching methods that need more time to be implemented in the classroom. Therefore, different implementation of technology education has resulted in different learning outcomes. In New Zealand, students learnt practical and technological issues, while their peers in Saudi Arabia were not given such opportunities because they were taught based on theory rather than practice.

These findings also confirm that most participants have positive attitudes to teaching science and technology, and they suggested some ideas to improve teaching technology education, which will be discussed later in this section. These findings helped me explore the current situation of technology education internationally and nationally, and understand and reconceptualise science and technology education in the Saudi primary curriculum by offering suggestions that could improve the teaching of this subject in the Saudi primary education system.

6.2 Implementing Technology Education in New Zealand and Saudi Arabia

As mentioned in the key findings section, there are differences in the implementation of technology education in the two countries. This difference will be elaborated in this section, supported by the findings obtained from documentary analysis, classroom observation, and interviews. The discussion is presented in the light of the literature review to demonstrate how the findings fit with previous work.

6.2.1 Technology education in the official documents of New Zealand and Saudi Arabia

The findings of this research regarding how technology education is documented in New Zealand and Saudi Arabia helped me to answer the first sub-questions of the research, and

to reflect on the debate that has arisen in the literature about the relationship between science and technology in the curriculum. The notion that technology is applied science was the spark for this debate among scientists and technologists regarding the relationship between science and technology (Kipperman, 2006). This debate has created two schools of thought amongst those who work in the fields of science and technology. The first considers technology as applied science and claims to integrate technology with science (Albe & Bouras, 2008). The other side considers science and technology to be independent with different goals, methods and people who have different skills and knowledge (Gardner, 1994; Sparkes, 1993).

Based on the investigation about the relationship between science and technology given in the literature, I argue that science and technology are separate disciplines but have elements that overlap and interact. This overlapping and interaction was represented in the model that I developed in this thesis (Figure 3-1, in chapter 3: Almutairi's model of the relationship between science and technology). This model demonstrates the relationship between science and technology and might help teachers to distinguish between the two subjects in order to improve their skills in teaching science and technology. For example, this model helps science and technology teachers to teach any topic related to science or technology, or they can integrate science and technology to teach the topic. This can happen by selecting which discipline will be taught, and the teachers can then follow the arrows in the division from up to down that help them to understand what issues they need to consider when they want to teach either science or technology. The model provides them only with the key issues that they must be aware of to teach science and technology effectively.

The current study and the document analysis have found that the respective educational policies of New Zealand and Saudi Arabia show that technology education is important in education because it provides students with the essential skills they need to understand technology. As can be seen from the summary of the findings (shown in Table 5.25 in Chapter 5) the New Zealand educational policy has stated the importance of prioritizing the teaching of science and technology. Interestingly, the analysis of the educational policy showed that there was more emphasis on the importance of including and teaching technology in the Saudi educational policy than in its New Zealand counterpart but the findings of this study found that there was a significant gap between theory and practice in

the Saudi context. The Saudi educational policy states the importance of including and teaching technology in several articles and section and claims: (1) knowledge and technology is a means to develop the country in different aspects and will help the country catch up with other advanced countries; (2) schools should offer scientific and technological skills to allow students to contribute to the creation of products; (3) schools should allow students to study scientific principles and scientific thinking that help to improve their creativity, and (4) one of the primary education objectives is to foster the creative skills of students and to help them to appreciate practical works. I refer to the wording and the structure of the policy in Saudi education, which includes nine sections. Thus, the repetition in the policy allows the term ‘technology’ to appear in different sections and articles. For example, Article 59 in Section 2 and Article 78 in Section 3 of the policy have the same meaning. I believe that the New Zealand policy is better than the Saudi policy because the former provides a precise and clear statement that emphasises the teaching of science and technology and because it has inspired those who work in this field to identify the relationship between science and technology in order to determine their objectives and content. This policy allowed producing further materials that support the teaching of science and technology as a response to the policy.

The documentary analysis showed that technology education in New Zealand is a separate subject called “Technology Education” that has its own statement, represented in a document called “Technology Curriculum Support” developed by the Ministry of Education (2007b) based on a Technology Education Document (Ministry of Education, 1995b). The findings confirm that this statement supports teachers and students in the implementation of technology education and is one of the main resources for technology education. For example, Jude (one of the participants in this study) mentioned that she uses the New Zealand curriculum framework and technology curriculum support package to teach technology education and they were useful for this purpose. The findings of the present research are similar to those of Harlow, Jones and Cowie (2004) who investigated New Zealand teachers’ experiences of the implementation of the technology curriculum in New Zealand schools from Years 1–13. In that study, 67 percent of the teachers declared that a technology curriculum statement was helpful in planning their classroom activities.

In contrast, technology education in Saudi Arabia has been integrated with science subjects and the concept of technology has not been separately identified. This integration is

attributed to the policy of education in Saudi Arabia, which considers science and technology to be integrated subjects. This notion is not explicitly declared in the policy but can be derived from the policy wording, which combines the two subjects in the articles that are pertinent to science and technology. For instance, in Section 2, which covers the general purposes and objectives of education in Saudi (Article 59A), it is stated that schools should teach scientific and technology skills to allow students to contribute to making products. In addition, Article 59B states that schools should teach students scientific principles that help to improve the creative level. I submit that the phrase “making products” in Article 59A and “creativity” in Article 59B are fundamental aspects of technology education. Achieving solutions and creativity are among the aspects of technological practice identified by Gawith (1999).

The different interpretation of technology education in the educational policies of New Zealand and Saudi Arabia has led to the creation of a clear definition of this subject in the New Zealand curriculum, while the Saudi Ministry of Education has not defined technology education. The literature has only provided a few definitions of technology education. In the New Zealand curriculum, technology education is defined as intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) (Ministry of Education, 2007a). The literature in Saudi Arabia has defined technology education as “A discipline that focuses on teaching technology as a human activity including control systems and their basic elements which include tools, materials, knowledge, skills, people, power, time and funding” (Fath-Allah, 2006). This definition was given by an academic who realised the real meaning of technology education that should be included in the curriculum. As one of curriculum experts in Saudi Arabia, I can attribute this issue to the weak collaboration between the Ministry of Higher Education and the Ministry of Education in terms of reviewing and developing the curriculum. The two ministries were recently amalgamated, which is hoped to lead to improved curricula.

The rationale of teaching this subject was articulated in the official documents of the New Zealand curriculum and Saudi science textbooks. By comparing both rationales, I found that the general aim of teaching technology education was clearly identified in New Zealand curriculum; it aims to develop a broad technological literacy that will equip students to participate in society as informed citizens. In Saudi Arabia, on the other hand,

greater emphasis was given to rationalizing the teaching of science and technology. Interestingly, practical skills were emphasized in both contexts to enable students to make models and products. This is consistent with the literature review, which indicates that practical skills play a major part in technology education in the United States, New South Wales, England, and Finland.

Moreover, the findings indicate that the objectives of technology education in the New Zealand curriculum were clearly identified for each year, from Year 1 to Year 13. On the contrary, an analysis of science textbooks from primary education in Saudi confirms that the objectives did not show which ones related to science or technology. These objectives focused on providing students with a practical methodology of thinking that enables them to analyse pictures, read and write scientifically, draw, make models, and connect knowledge to life. I argue that analysing each skill separately could lead one to consider this skill as one of the skills of science and technology or as a skill of only one of them. The issue is not related to the integration of science with technology that can be taught together, but rather that objectives of science and objective of technology are different, which influences teaching methods.

The curriculum developers did not identify which skills represent science and which represent technology in order to help teachers select whether they teach them separately or integrate them in the classroom. In addition, the curriculum developers declared that the philosophy of those science textbooks was to attempt to link science and technology with other disciplines such as mathematics.

One significant difference reported in the current work is related to the structure of technology education in the curricula of the two countries. In New Zealand, the subject is based on three strands that form the technology education concept: the technological practice strand, the technological knowledge strand, and the nature of technology strand. Each of these strands has specific components that reflect these strands. Also, there are many areas of learning of technology education, such as control, food, ICT, structural, and biotechnology. On the other hand, the subject has no specific structure in Saudi Arabia, but I was able to derive the structure from the introduction of the textbooks, which reflects the entire philosophy of science and technology. There are two main aspects – scientific knowledge and practical skills – that can be considered as the structure of science and technology. I compared the structure of science and technology in Saudi Arabia with that

of New Zealand and other countries investigated in the literature. The current work suggests that only the practical skills were a common element in the structure of technology education in the curricula of these countries. All learning areas of technology education in these countries aim to develop practical skills among students.

Interestingly, the current work indicates that there is no specified content of technology education in New Zealand, but a school's technology department can decide what topics will be taught and use the New Zealand education curriculum as a guide to teach technology. In Saudi Arabia, each science and technology textbook includes units and topics that must be taught in the classroom. This study reports a major issue that has helped position technology education as a poor subject in the curriculum. The issue is that there is a weak connection between the academic authors who teach at the universities and are interested in science and technology field, and those who develop curriculum at the Ministry of Education. The evidence is that there is no consistency between the description of technology in the Saudi curriculum and that given by the literature in the Saudi context. I attribute this inconsistency to the education system in Saudi Arabia, which is managed by two separate ministries: the Ministry of Higher Education and the Ministry of Education. Having two independent ministries with different policies and different educational purposes has resulted in some studies and suggestions presented by academic thinkers to improve teaching technology education in the Saudi curriculum not being considered.

6.2.2 Technology Education in New Zealand and Saudi Arabia classroom

Conceptual knowledge ("know that") and procedural knowledge ("know how") are reported to be significant components of implementing technology education in the classroom (McCormick, 1996). McCormick also indicated that solving problems and design represent procedural knowledge and are key strategies for implementing technology in the classroom. Thus, a variety of teaching methods are required in order to effectively teach the technology education that is associated with authentic learning.

The findings of the research reported in this thesis indicated that the teachers implemented a variety of teaching methods, and that problem-based learning, enquiry learning, discussion, designing and student self-assessment, together with collaborative and individual learning, were key strategies implemented to teach technology education in

New Zealand classrooms. Using these methods in the classroom indicates that technology education was effectively implemented in Years 2 and 6 in the selected school in New Zealand.

I believe that implementing technology education in New Zealand classrooms reflects the elements of conversation in technology education in the classroom identified by Turnbull (2013). She identified four elements: funds of knowledge, making connections and links, management of learning, and technology knowledge and skills. These elements can be interpreted in light of teaching and learning strategies used in the Year 2 classroom in the current study. A fund of knowledge represents the prior knowledge. This element was evident when the teacher asked the students about the information they previously had about geckos. Making connections and links represents students' ability to implement knowledge from what they learn in school. For instance, they justified the materials to be used in the design, such as why the sharp knife and the light are used. Students also discussed mathematical terms such as size, circles and triangles. The management of learning that reflects techniques and strategies used by teachers and students to improve learning was obvious because the students were involved in different techniques and strategies, which made the lesson enjoyable and meaningful. The three previous elements work together to create the final element, which is technological knowledge and skills that resulted in improving students' knowledge about design products that reflect the core concept of technology education.

Furthermore, technology education was implemented in this classroom by applying some of the six effective teaching/learning strategies that Gray and Smith (1998) identified as enabling students to achieve the goals of technology education. These are: (1) ingenuity challenge; (2) topical investigation; (3) modular activity package; (4) product generation; (5) research and experimentation, and (6) engineering design and development. In the present study, the fourth strategy (product generation) and the sixth strategy (engineering design and development) were used for technology education in the Year 2 classroom. By applying the product generation strategy, the students were involved in an activity that provided them with skills of processing shelters and houses in a simple way that met their intellectual capability and ages. The engineering design and development strategy helps students to identify a problem; specifically, how they can protect the gecko. This problem is related to technology in nature. Students then developed a solution to the problem by designing a suitable product (the "house") to solve the problem.

All methods and strategies implemented in the Year 2 classroom helped students to “know that” designing an enclosure for the gecko comprises different items that work together and they “know how” to design it, beginning with insightful thinking to find a suitable solution and to end by producing the product that will solve the problem. The literature indicates that conceptual knowledge (“know that”) and procedural knowledge (“know how”) characterise good practice of implementing technology education into the classroom (McCormick, 1996). Conceptual knowledge and procedural knowledge are crucial concepts for implementing science and technology in the classroom and can be used as a norm to differentiate between science and technology. This was clearly explained in the model proposed in Chapter 3 to explore the relationship between science and technology (see Figure 3.1). Understanding procedural and conceptual knowledge and the relationship between them will help teachers teach students in a way that helps them to be technologically literate. Students who are technologically literate know parts of a particular product and how to do it through using problem solving and strategic thinking that represent procedural knowledge. In addition, these students can identify the relationship between parts of this product and how they work together, which represents conceptual knowledge (McCormick, 1997).

In Year 6, the focus of the unit in the classroom was directed towards the “technological knowledge strand” as one of the three components of technology education in New Zealand and this indicates a narrow view of technology education by this teacher. Providing students with technological knowledge was explained by Dakers (2007) who argued that the procedural concept refers to technological knowledge, while the conceptual concept relates to the development of knowledge about technology. Together, these two concepts produce the concept of technological literacy. Turnbull (2013) explained that technology knowledge can exist through the combination of other funds of knowledge, making connections and links and the management of learning, which were discussed and explained in the previous section (implementing technology education into a Year 2 classroom). I propound that funds of knowledge, making connections and links, and management of learning are applications of technology practice that shape technological knowledge. This argument is supported by earlier studies in the literature. For example, France and Compton (2006) explained that technological knowledge and technological practice work together to support the concept of technological literacy and they claim that technological knowledge and technological practice should be taken into account in technology education

classroom if the school aims to develop students' technological literacy. In addition, the Ministry of Education (2007a) articulated that the technological knowledge strand helps students to understand how and why products work the way they do, by learning how functional modelling is used, how prototyping is used, and understanding materials' properties and uses.

The data (classroom observations) show a noticeable improvement among students in terms of understanding what a robot is, what parts help to run it, how these parts work together, and technological vocabulary. I realized that hearing the discussion with the teachers reflects their understanding of what the robot is and knowledge about its parts that help to run it through these steps: inputs, processes and outputs that are major parts of any system of any product. In addition I noticed that the students used terms such as ultrasound, sensors, command, software, program, product, and design, which indicates that the students have become familiar with some technological terms. These findings are clearly supported in the literature, which showed similar strategies implemented by De Vries and Koski (2013) in Years 8 and 10 with regard to how the system is taught and received by pupils. The current study revealed that the pupils showed some understanding of machines consisting of parts with different functions, or that a sequence of steps is required to complete a process. However, the findings of the present study are different to those of De Vries and Koski (2013) in terms of understanding the system. The students in the current study showed a good understanding of the system, which consists of many parts working together, while the students in the other study understood the system as an experience of the uses instead of the parts of a machine that work together. I refer students' understanding of the system in the other study to the way that the teacher constructed the unit. The teacher might not identify the key terms for the students at the beginning of the unit, which led students to understand the "system" incorrectly. To avoid such confusion, teachers should identify key terminologies when they start teaching any unit, and they should remind students of the key terms in each session to make sure they become familiar with them. Also, students can design a poster that shows these key terms and their definitions; the poster can be placed in a place in the classroom that would allow students to read it easily.

Comparing the ways that technology education is taught in New Zealand and Saudi Arabia revealed that in New Zealand the teachers used several modern teaching methods such as

problem-based learning, enquiry learning, discussion, designing, and student-self assessment, which reflect the processes of teaching and learning in the classroom, while the Saudi teachers used a few traditional teaching methods such as lecture style, discussion and, occasionally, collaborative learning. I argue that these limited teaching methods led to students being taught theoretically without engaging them in practical activities that would help them to understand how, for example, the windmill was invented, how it works, and how it has developed technologically. For instance, discussion strategy, as one of the pedagogical strategies used to teach technology education, was implemented into Years 5 and 6 classrooms to help students to learn collaboratively. This kind of teaching method was suggested in the literature as a helpful method that gives students the opportunity to display their thinking and intellectual abilities (Fath-Allah, 2006). I feel that this discussion strategy is a general strategy that contains several elements that help to cover many aspects of any topic under discussion. The literature reveals that these elements shape the “penta-method strategy”, which is used in the teaching of science and technology. Al-Hatriti and Al-Mazroa (2013) explained these five elements as follows. (1) Preparation: prepare students to be engaged in the discussion. (2) Exploration and Investigation: students implement activities to explore a particular topic by collecting data about it; they then record the data to be used for the investigation. (3) Explanation and Interpretation: students explain and interpret the data about the topic that was investigated. (4) Evaluation: students evaluate the topic based on elements determined by them and the teacher. (5) Enriching and Expansion: students can read beyond what they have learned at school to expand their knowledge about the topic.

I also suggest that the way of teaching science and technology in the Saudi school shows there is a gap between theory and practice in terms of the science and technology curriculum. The practical activities were indicated in the objectives of science, but the teachers were not provided with guidelines, such as the case in the New Zealand context, that help them to practically teach these activities, including practical teaching steps, suggested teaching methods, and ways of integrating technology with science in the classroom.

Interestingly, the students in both contexts were taught authentic topics, which reflect one of the important outcomes of teaching technology. These findings support Turnbull’s argument (Turnbull, 2002) regarding the importance of involving students in authentic

activities. She argued that, by involving students in activities that are authentic to technological practice or real-world technology, teachers are able to provide interesting and relevant learning for students. In New Zealand, the focus of the unit in the classroom was directed towards the “technological practice strand” as one of the three components of technology education in New Zealand. Providing students with technological practice skills is in line with Turnbull’s argument that “technological practice” is one of the main strands of technology education in the New Zealand curriculum. By teaching technological practice, students can learn through three dimensions: planning for practice, brief development, and outcome development and evaluation. These dimensions characterise the technological practice strand in the New Zealand curriculum. In Saudi Arabia, the topic was authentic because it provided students with information about how wind energy can be transferred into another form of energy that moves objects and generates electricity by using windmills. The literature suggests that this is one of the units that should be included in teaching technology in the education system that aims to provide students with information about the technological world; for example, students can learn about wind and solar power-generating systems (Fath-Allah, 2006).

Another interesting point from the findings is that the nature of technology, as a strand of technology education in New Zealand, was evident in teaching science and technology in the Saudi context. Students had the opportunity to discuss the impact of energy on the environment by discussing its negative and positive impacts. They also discussed possible ways to protect the environment. Teaching this concept complies with the characteristics of technology identified in the literature by Mazen (2009), who indicated that understanding the relationship of technology with society is a major component of technology, which should be taught in the classroom alongside other components. This lesson was relevant to technology education but was not as effectively taught as it should be in order to support the teaching of technology education in the classroom. In my opinion, this point pertains to two main issues. Firstly, the teacher lacked an understanding of the differences between science and technology and how these differences can affect his ability to teach science and technology; the teachers declared this issue during the interview. Without understanding the relationship between science and technology, the teachers cannot teach this subject in a way that helps students learn effectively in the science and technology classroom. Also, such an understanding is a major indicator with

which to identify those who must be involved in training course to develop their professional skills.

The second reason is that the teacher has to hurry through a tightly packed curriculum that does not allow him to skip any practical task. For example, he brought into the class some models of fans that work based on solar energy but he did not discuss it as a product with the students so that they could understand how the product works, how was it made or the types of materials used to make it. By comparing that to the New Zealand context, although the teachers in New Zealand complain about crowded curriculum, the data indicates that there are fewer subjects in the New Zealand curriculum than in the Saudi curriculum. Also, teachers in New Zealand are not required to teach the syllabus determined by the Ministry of Education; instead, they decide on the syllabus according to the allocated time given by the school. However, the teachers indicated that they have insufficient time to teach technology in a way that helps students to learn better in technology. The teachers mentioned in the interview that they need to teach several technological topics and that teaching them effectively requires at least four sessions a week, which is impossible because there are other subjects have to be taught as well.

In terms of teachers' efficiency, the findings indicate that teachers in New Zealand had the ability to teach technology education and were able to apply the concept of technology education in the classroom. They provided students with suitable technological topics and discussed these topics with the students based on the technology strands such as technology practice and technological knowledge. The teachers were aware of the entire concept of technology education and how it is documented and how it should be implemented in the classroom. However, the teachers articulated that they have not been involved in training courses to develop their skills to teach technology, although the findings show that they effectively implemented technology in the classroom. I can attribute this to the available resources, such as the curriculum, technology education support document, and Techlink (online resources), which is a site dedicated to technology teachers, students and anyone with an interest in technology education in New Zealand. In terms of the materials used to make products, the teachers expressed that the lack of these materials pushes them to ask the students to bring the materials to complete the project; they refer that to a lack of funds allocated by the school.

The Saudi teachers, on the other hand, were ill-qualified to teach technology education because they were not involved in training courses that would improve their skills in terms of teaching technology within science and they are not supplied with suitable resources. Teachers in New Zealand used these resources to teach technology, despite also complaining about a lack of training. In addition, it is obvious from the data that the Saudi school that was observed in this study was focusing more on teaching science because they were influenced by the educational policy and the strategy of teaching science and technology that place less emphasis on teaching technology education. Providing the Saudi teachers with guidelines, including physical documents and online resources, would help some of the teachers who have the desire to improve their professional skills until they have the opportunity to be involved in training courses related to science and technology education.

6.3 Findings Gained from Interviews with Technology Education Teachers in New Zealand and Saudi Arabia

It is important to explore technology teachers' perceptions of technology education. It is also important to understand the extent to which the current teaching technology actually reflects the theoretical framework for the subject, as this will lead to a better understanding of how technology education is documented and implemented in the classroom. Two technology teachers and two technology experts were interviewed in each country.

The current study reports that teachers in New Zealand believe that design and the hands-on concept make technology education enjoyable because students have the opportunity to touch things and think about them. This is consistent with the results of the research conducted by Almutairi (2009). In that study, technology teachers acknowledged that technology is a unique subject that helps students move from abstract learning to constructive and concrete learning. The present study shows that there was less enjoyment among students in Saudi science and technology classrooms. The participants revealed that students have less enjoyment of the current science curriculum because it focuses on theory rather than practice. This point is also supported by the data collected from classroom observation, which indicate that students have less interaction and motivation in the classroom because the teachers used a lecture style to teach a theoretical topic, which did not allow them to enjoy the lesson. These findings show the difference in the impact that implementing technology education has on students in the classroom. This means that

the level of acceptance and enjoyment of the lesson among students is positively influenced by allowing students to perform practical activities in science and technology education.

The findings of the present study show that the New Zealand teachers were aware of the relationship between science and technology. Teachers work together in the science and technology syndicate in their schools. For example, Jude indicated that she focuses on a science topic in the first term and technology in the second term. In contrast, David integrated science and technology by teaching “thermal insulation”. He showed students how to keep things hot or cold – representing “science” – while investigating the materials used to do this, which represents “technology”. The teachers in Saudi Arabia also recognised this relationship. For example, one of the participants explained that environmental issues are “science”, while technology focuses more on making machines and devices. However, the Saudi teachers’ understanding of this relationship does not mean that they teach science and technology together effectively, and this is what the present study found. My interpretation of this issue can be referred to the data, which shows there was a difference in terms of the methodology and the pedagogy of learning used in each country. In New Zealand, the system of teaching and learning gives teachers flexibility to apply their professional knowledge in the classroom. They can use a range of (evidence-based) strategies to help their students learn. On the other hand, the Saudi participants indicated that the crowded curriculum, poor emphasis on practical activities in schools, and poor practical topics hindered their ability to apply their professional knowledge in the classroom.

I believe that good implementation of any subject requires appropriate resources and materials in order to provide students with maximum opportunity of learning. Exploration of this aspect shows that there were a range of resources in the New Zealand school compared to the Saudi Arabian school. The current study reveals that the availability of resources (especially curriculum guidelines and statements) in the New Zealand context helped teachers to enjoy teaching technology and teach it as it should be taught. In Harlow et al.’s (2004) study, 40 percent of primary teachers found the curriculum statement helpful in planning their classroom activities. The use of these resources was also different in both contexts according to the purpose of the implementation, which focuses on technology in New Zealand and on science in Saudi Arabia. Every activity in the

classroom is impacted by the pedagogy used in the school, which, in turn, is impacted by the entire philosophy of education in each country. I argue that the quantity and quality of the resources used to teach curriculum depends on the level of understanding among the influential people in each country regarding the purpose of these curricula and the outcomes that they want to achieve. This understanding will help these individuals prepare the next generation, which can help develop its community and the international community.

In New Zealand, the teachers indicated that technology education is clearly defined and they recognize the development of this subject. In the Saudi curriculum, the subject has been integrated with science. The result is that the New Zealand students make good progress in terms of technological literacy, while the Saudi students do not learn much about technology. This was clear from the learning outcomes that I noticed in the classrooms in New Zealand and Saudi Arabia.

The data shows that technology teachers in Saudi Arabia faced certain difficulties that precluded them from teaching technology, as they would like. Crowded curricula, school timetables, and a lack of professional development were the main problems with regard to teaching technology. Some of the difficulties that teachers in New Zealand faced included timetables, crowded curricula, a lack of resources (materials used to make products) and budgets, and a lack of professional development. These issues are different in both contexts. In Saudi Arabia, the crowded curriculum means that there are 12 subjects in the timetable (see Table 2.1), while in New Zealand it means there is imbalance between the subjects in the timetable. For example, there are fewer sessions for technology education than for numeracy and literacy.

I believe that the main issue facing Saudi teachers is the crowded curriculum and professional development. In terms of the crowded curriculum issue, students must learn 12 subjects, which is really above the ability of such young children, who need only to learn about basic subjects like numeracy and literacy. Also, each subject includes many topics that prevent teachers from planning for a lot in a short time. Professional development is also a major issue that science and technology teachers face because all training programs are directed to science while technology education is not given any

attention. If the two issues persist, that will affect the quality of primary education in general and technology education in particular.

6.4 Findings from Interviews with Technology Experts in New Zealand and Saudi Arabia

In general, technology experts in New Zealand have positive attitudes towards teaching technology education; they believe it is an essential subject that must be included in the curriculum as a separate subject. Experts in New Zealand considered the unique knowledge involved in technology education, and the different philosophy of this subject, as the main reasons for this subject to be a separate subject in the curricula. In Saudi Arabia, the experts opined that Saudi schools are not ready for technology as a separate subject.

The experts in both countries had varying opinions about the issue of integrating technology education with other subjects. Andy from New Zealand and Tariq from Saudi Arabia were opposed to the idea of integration, whereas Kate from New Zealand and Ibrahim from Saudi Arabia support the integration. Kate provided more explanation about this issue by providing three suggestions to teach technology education, she suggested that technology education can be taught as a separate subject, integrated with science, and separated curriculum but integrated in delivery keeping the integrity of specific curriculum content.

These responses reflect the on-going debate among educators about whether it is useful to integrate technology education with other curricula or whether teaching it separately would be more appropriate. I also believe that we cannot stop this debate by selecting one option and neglecting the other, but there is a potential compromise. The policy makers and curriculum developers should clearly identify science and technology in the relevant policies, and then introduce guidelines to teach the subject either as an integrated or separate subject. I suggest that the Ministry of Education give schools more flexibility to select which method is suitable for teaching students based on the policy, the agenda and the resources of each school. Considering such a suggestion would significantly influence the political and educational future of countries such as Saudi Arabia.

The experts provided some suggestions that could help improve the teaching of technology education in the Saudi curriculum. According to their suggestions, there is a need to establish a research centre of science and technology that aims to investigate this idea and introduce it to schools. The centre should give more attention to technology education by conducting more research and exploring other international experiences that will help to implement this subject appropriately. One participant indicated that there is a centre of science and mathematics in Riyadh, but that it only focuses on science and mathematics. I believe that the centre in question can be developed by taking into account the participant's suggestion. One of the participants claimed that different sectors should work together to develop the teaching of technology education. These organisations – the Ministry of Education, universities, Technical and Vocational Training Corporation, King Abdullah City of Science and Technology – can investigate this idea in depth to establish a good foundation of technology education. Establishing this centre will provide a range of support for schools by fostering the development of technology education in schools and also supports professional, curriculum and resource development in technology education. In addition, the centre will encourage research in technology education by bringing teachers, students and academics together to investigate new ideas that help to improve teaching science and technology in the Saudi school.

6.5 Findings Gained from Survey Participants in Saudi Arabia

The findings indicate that the Saudi government should review the primary curricula so that it is modern and updated and keeps pace with the current technological revolution. This will allow schools to prepare students who are creative and innovative. To achieve this, primary education in Saudi Arabia must be developed to respond to students' needs. I believe that this can happen by aligning the current traditional learning environment to a modern learning environment that supports strengths-based teaching and can offer students and teachers flexibility, openness and access to resources (Osborne, 2013). I believe such a learning environment can help address the current social and environmental issues and would enable students to investigate these issues in order to gain a better understanding of them, which might help the students suggest possible solutions for them. This means that schools will give students more opportunity to learn practically through solving problems, investigating ideas, making and designing products, and evaluating their products and their

learning in keeping with cognitive skills such as reading and acquiring mental skills to develop their ability to think conceptually.

The vast majority of the participants who responded to the questionnaire agreed that students need to acquire knowledge such as technological knowledge and some basic technological skills that help them keep pace with and understand technological change. I submit that technology education is the only subject that can provide students with this knowledge. This is supported by some of the positive aspects of technology education that have been found in this study. These include developing pupils' capabilities to solve technological problems; helping students to learn how they design technological products; helping students to be aware of the interaction between technology and society; and helping students to recognise the environmental issues caused by technological development. Following my suggestion would mean that Saudi students would be involved in a modern learning environment.

Moreover, the majority of tutors and technology advisors believe that including technology in the Saudi primary curriculum will help develop primary school pupils' awareness and understanding of the interaction between technology and society. In addition, students can take responsibility regarding environmental issues caused by technological development. All these positive aspects of technology education will help develop primary school pupils' appreciation of the importance of technology to Saudi Arabia's economic development.

One of the reasons behind existing traditional learning environment in the Saudi primary education is type of the curricula. The current curricula in general and the science and technology curricula in particular, have been seen by science teachers as insufficient to enhance students' technological literacy. That means more work needs to be done to review the curricula in order to overcome this issue.

The responses to the open-ended questions in this study suggested that the poor implementation of technology education in Saudi primary education was due to poor practical learning (theory rather than practice), poor definition of technology education, and an imbalance of content of science and technology. These factors tackled the development of technological literacy within the current curricula. This means that literacy

in Saudi Arabia is only about teaching, writing and reading, which have been taught by applying conventional methods that push students to retain information without developing the thinking and technical skills of students. In addition, the document analysis shows that curriculum developers did not consider including a clear definition of technology and they did not balance the content of science and technology. It is insufficient to include a statement in the introduction to the textbook that teaching technology and practical activities are among the important objectives of the subject without providing additional information such as term definitions, objectives of science and technology, suggested ideas to be taught in the classroom, suggested pedagogies, or identifying possible learning resources that the teachers need in order to understand what these activities are and how they can be taught in the classroom.

The above-mentioned findings could inspire curriculum developers to give more attention to technology education in order for it to become a key subject in the curricula. However, there was no agreement among the respondents regarding how this subject can be taught. It has been suggested that it can be taught either separately or integrated with science. Teaching technology separately was the preferred choice among the participants, who argued that such a separation would enable students to spend a reasonable time studying this modern subject. Modern education requires schools to give more attention to practical learning, and technology education has special features that need to be taught independently in the technological era. In contrast, the other participants offered reasons why technology education should be taught as a separate subject, integrated with science, and a separated curriculum but integrated in delivery, keeping the integrity of specific curriculum content. These reasons included: avoiding a crowded curriculum, the belief that science and technology are interwoven subjects with similar ideas, and implementing technology education step by step.

I believe these findings are important and should be taken into account to reform teaching science and technology that will reflect on reforming education generally. The findings of the current work concur with a previous study, which stated that “science education reform is a systemic issue in which sponsors, advocates, change agents, and targets of change must work together to achieve the development and implementation of the innovation” (Al-Ghamdi & Al-Salouli, 2013).

6.6 Principal Implications and Recommendations of Research Findings

This study found three key factors that play a major role in implementing technology education: Educational policy, curriculum content and pedagogy, and teachers' efficacy.

Interpreting the findings of Study 2 (in Saudi Arabia) in the light of Study 1 (New Zealand) in teaching technology education, along with previous studies, have led me to suggest some practical implications of the findings that could lead to improve teaching technology education in Saudi primary schools. These implications will be discussed based on the three factors mentioned in the previous paragraph. Each implication will be followed by specific recommendations.

6.6.1 Educational policy

Any educational reform must start by reforming the educational policy that governs the operation of education system. Therefore, and according to the Education Critical Theory (see Chapter 3), reforming education involves critically re-examining and reconstructing all aspects of education, including the curriculum, the pedagogy (or teaching style), educational policy, the influence of corporate power and the so-called hidden curriculum. My investigation of educational policy in New Zealand and Saudi Arabia found that in the New Zealand educational policy there was a concise statement to show the emphasis on teaching science and technology. This policy drove the Ministry of Education in New Zealand to draw up a plan for implementing the teaching of technology education. This plan included suggestions for other documents that the schools need in order to teach this subject. New Zealand's experience in terms of educational policy could inform the Saudi context by calling for urgent action to review the current educational policy, which includes several articles and statements about technology. These articles and statements have not been clear for educators who struggle to identify the relationship between science and technology based on this policy that led to a significant between theory and practice. Moreover, the educational policy in Saudi Arabia did not address key aspects that play a major role in shaping technology education concept such as defining terms related to science and technology, identifying general goal of teaching science and technology, identifying technology structure, and identifying objectives of science and technology will help to present a clear picture of science and technology in the curriculum. This action will

help the curriculum designers and teachers to develop a content that reflects nature of science and technology.

Thus, this study recommends that the educational policy should be reviewed to be a clear and reliable official document that addresses all required aspects to identify the nature of science and technology in order to foster teaching technology education that aims to develop students' technological literacy.

6.6.2 Ideas for developing curriculum and pedagogy

In New Zealand, organisations such as the Ministry of Education, universities, the Technology Education Subject Association, The Institution of Professional Engineers New Zealand (IPENZ), and industrial sectors, work together to develop technology education. Infusing different professional experiences into the technology education field can help produce a professional subject that can help create technological generation that helps to promote the society, particularly in the industrial and technology field.

Therefore, this study could help the Saudi government to reform science and technology education by calling for cooperative work between organisations to develop science and technology education; for example, the Ministry of Education, universities, technology colleges, the King Abdul-Aziz City of Science and Technology, and the industrial sector. This will help the design of technology education content that is connected to problems and issues that are real for the wider Saudi community and have immediate relevance to the lives of the students. The findings revealed that the current content of science and technology does not address issues related to technology education, such as the impact of technology on societies and the environment and to explore how developments and outcomes are valued by different peoples in different times. Also, it does not help involve students in practical skills such as designing products that improve their critical and technological thinking.

The findings also inform work on developing science and technology education content that encourage students to be involved in activities that reflect problem-solving-based learning, enquiry learning, discussion, designing and student-self assessment. Using these teaching methods will help to provide a better implementation of science and technology in the classroom. The findings in this study (classroom observation) provide evidence that

applying modern teaching methods in the New Zealand classrooms helped improve students' technological literacy, as they were able to design some models based on the technological skills taught in the classroom.

Therefore, this study informs the Saudi context of technology education should not only depend on science and technology textbooks but should also be accompanied by a clear guideline "Technology Curriculum Support" that helps teachers to implement technology education in the classroom. Such a resource will help teachers understand to identify conceptual "know that" and procedural "know how" ideas that they need to teach science and technology education. These concepts were important factors to implement technology education in New Zealand classrooms.

Conceptual and procedural knowledge can be used to effectively teach a range of essential areas of technology, such as food technology, ICT, hard materials, biotechnology and electronics. These areas can be also considered to develop technology education that does consist of different practical areas. Putting this idea into practice can help students understand these areas, which impact their future careers.

Furthermore, the current study found that teachers were not given flexibility to select the topics and time for teaching them, in order to give students the opportunity to learn more about designing products, using robots, industrial practices, communications technology, the features of systems, developing creative thinking, and appreciating handicrafts and respecting those who practice technology. This situation prevented teachers from providing their students with practical tasks that need more time and focus that is important to support a student-centred approach. By accepting this suggestion, the Ministry of Education will offer a modern learning environment for students by (according to suggestions from the participants) helping students to learn how they design technological products, helping students to be aware of the interaction between technology and society, and helping students to recognise the environmental issues caused by technological development.

Thus, this study makes the following recommendations.

- 1- Science and technology curricula developers should review the current science curricula to create a balance between science content and technology content that will provide students with scientific skills, and it also improves their technological literacy to become innovative and creative learners.
- 2- Science and technology textbooks should be supported by a clear guideline “Technology Curriculum Support” that helps teachers to implement technology education in the classroom. The guideline can offer a variety of ideas and ways to teach a range of essential areas of technology, such as food technology, ICT, hard materials, biotechnology and electronics.
- 3- Teachers should be given greater flexibility to select the topics and time for teaching technology education in order to support a student-centred approach

6.6.3 Ideas for developing teachers’ efficacy

Science and technology teachers’ professional development is an important aspect that enhances their ability to teach science and technology. This is a key factor that would move science teachers towards a better level of understanding about the science and technology concept. Despite that this study found that the teachers in New Zealand articulated a lack of professional development but they were able to access to some online resources that inspired New Zealand teachers to teach technology education effectively. For example Techlink is an online resource that provides teachers with examples of contemporary teaching and learning in technology from early childhood through to vocational pathways into industry and enterprise. It also hosts t-news, a major information source for teachers across all technology subject areas.

The Penta-method and discussion were found to be the only strategies implemented in the Saudi classroom. Other strategies such as problem-solving, topical investigation, critical thinking, and product design were absent in the classroom. Science and technology have a range of ideas and concepts that reflect both theory and practice that need different teaching strategies to deliver them to the students. The way that science and technology were taught in the school I observed did not explore teachers’ and students’ creativity. It also fails to address students’ development of higher-level thinking. While using different

teaching methods will encourage self-learning, enhance student curiosity and expand their knowledge.

International experience is important to help decision makers establish a good foundation for teaching technology education. The international experience in terms of technology education has contributed to develop this subject in some countries. Working with international experts in this field is a good idea to start with to implement technology education. Thus, this study suggests establishing a partnership with technology education training centres in those countries that have experience in teaching technology education such New Zealand, USA and England. This would enable the partners to work together to lay out a strategy to reconceptualise technology education to ensure that it is implemented in an effective way. This will also give teachers the opportunity to be involved in training programmes in New Zealand that could improve their understanding of technology education.

Establishing a research centre of science and technology is another good idea to foster teaching both science and technology education in schools. The centre should give more attention to technology education by conducting more research and exploring other international experiences that will help to implement this subject appropriately. This centre could also suggest some teaching and learning recourses to teachers and students, and it can also guide teachers to make strong professional development choices. Techlink is a good example of technology education resources, introduced by the New Zealand Ministry of Education for teachers, parents and students.

Thus, this study recommends as follows.

- 1- The Saudi Ministry of Education should take action to develop suitable professional programs for science and technology teachers in order to develop their ability to teach science and technology.
- 2- The Saudi Ministry of Education should also provide the teachers with reliable resources for teaching this subject. Establishing an online community will be a good idea that might help the teachers particularly those who teach in remote areas or those who can not attend professional development programs.

- 3- The Saudi Ministry of Education should establish a partnership with countries that have enough experiencing in teaching technology education in order to explore possible ways to introduce this subject in the curriculum.
- 4- The Saudi Ministry of Education should establish a national centre of science and technology that fosters implementing science and technology in education.

6.7 Study Limitations

Any piece of research has certain limitations about what can be investigated. Although the above recommendations are worthy of consideration, there are some limitations that may affect the reliability and validity of the findings, particularly in terms of generalising the findings.

The sample size was relatively small for such a study, with one school in each context chosen. However, this was adequate for interpretation because the data was interpreted in depth with other resources – namely document analysis, interviews, and questionnaires – to collect data in this study. Such a sample can be accepted due to the in-depth and detailed nature of the approach (Mason, 2010). However, while this sample helps explain the phenomenon in a particular location, its findings cannot be generalised; particularly findings from classroom observations and interviews while data from documentary analysis can be generalized because these documents are the main source of teaching technology education for all education in New Zealand and Saudi Arabia.

Additional time and resources with which to extend the study to rural areas or other cities would have made it possible to obtain in-depth information from more than one school, selected from more than one city and rural schools from different regions by using both quantitative and qualitative methods. This would help increase the possibility of generalising data.

There is another issue regarding classroom observation: although this type of data collection has produced significant findings that can help enhance teaching practices, there remains a lack of consensus and confidence among the researchers regarding the findings of the research conducted in the classroom. Classroom observations can be criticised in the

sense that classroom observation research has not dealt with the theoretical assumptions of why a particular style of teaching or set of instructional variables influences student learning (Board, 2015).

In addition, the study could have been usefully expanded to cover principals' and primary students' points of view about technology education. Principals' perspectives are important in terms of their willingness to support the teaching of technology. Also, students could suggest the topics they want to learn and how they exist in the curriculum. Their views could assist in the creation of a preferable future scenario that policy makers can consider when formulating policies in order to review the policy and the curriculum to implement technology education.

Additionally, the research findings were limited by the fact that the researcher did not have access to observe teaching science and technology in a girls' school in Saudi Arabia. In Saudi Arabia, the government gives girls' education the same attention as it does to boys' education and it aims to equally reform education for both genders. Thus, investigating technology education in girls' schools helps to evaluate girls' education in order to suggest modern ideas to improve it. There are also two factors that inspire the researchers to conduct research about technology education in girls' schools. The first is exploring females' perceptions regarding technology education, which could differ from those of male students. The second is to explore the impact of home economics on girls' technological literacy; this area has been only taught in girls' schools and is an important area in technology education.

6.8 Directions for Further Research

Research studies often generate issues that are of further interest to researchers. Future studies can build on the results of the present study to enrich existing knowledge in the area of science and technology education. Ideas for further research have also emerged from this study.

It is clear from this study, and others, that teaching technology education has been significantly investigated by some countries, while others have given less or no attention to this subject. In terms of the Arabic context, especially the Arab Gulf countries, the current study is the first to investigate technology education in the curricula. It is also the first

study to compare science and technology in the Saudi curricula with science and technology in the international context. Therefore, this study could provide a good foundation for carrying out further research that might investigate the following aspects.

This study focused on investigating the perceptions of science teachers, technology tutors, and technology advisors of technology education. Thus, the findings of this study do not represent all the perceptions of everyone who can influence the future of technology education in Saudi Arabia. This creates opportunities for further research that involves a larger sample (policy makers, students, science supervisors, principals, academics, engineers, curricula developers, experts from the public and private sectors, and parents). Such a large sample will make it possible to generalise the findings obtained from all of the parties whose opinions can contribute to reforming education in the country.

The findings of this study represent New Zealand's experience of teaching technology education that might help inform the Saudi context. However, I believe that a single experience would not be sufficient to provide an integral picture of how technology education is implemented in primary education. Other studies can be conducted to compare technology education in Saudi Arabia with technology education in other contexts especially those countries that teach science and technology together such as Taiwan and Japan, in order to obtain further data from different contexts and perspectives. This would help to establish a comprehensive foundation of this subject that prepares students to live and work in today's interconnected and globalised world.

This study suggested a model (Figure 3.1, in Chapter 3: Almutairi's model of the relationship between science and technology) that might help teachers teach science and technology. This model may be worth investigating in order to ascertain whether it is useful or must be improved in order to be used as a suitable guide for the teachers.

6.9 Conclusions

The overall aim of this study was to explore how technology education is structured and implemented in the observed primary schools in New Zealand and Saudi Arabia. The study incorporates a partial CET framework to describe the primary school contexts in the two countries and makes recommendations for application in the Saudi context. Therefore, the focus of the study was to understand how New Zealand implemented technology education, in order to inform further developments of the subject in the Saudi curriculum. The conclusions are based on official documents, interviews, survey, and classroom observations. In terms of the classroom observation there was only one school in New Zealand and one school in Saudi Arabia and leads to a recommendation for further research to determine if these conclusions are consistent across all (or at least a considerably greater number of) schools in both contexts. In addition, data gained from the small participants who were interviewed, can not be truly representative of the whole population of teachers, technology advisors, and technology experts in New Zealand and Saudi Arabia. Only data from documentary analysis can be generalized because these documents are the main source of teaching technology education for all education in New Zealand and Saudi Arabia.

The research findings suggest that technology education was implemented differently in the primary schools observed. This was one of the main reasons for greater levels of technological literacy among students in New Zealand than in Saudi Arabia. Based on the data derived from a number of sources and documents, technology education is an independent subject in New Zealand, with its own philosophy. In Saudi Arabia, technology education is embedded within science education. Therefore, the philosophy underlying technology education was much less transparent in Saudi Arabia.

There was also a major difference in practice, affected by social, cultural and political issues that directly influence educational policy, curriculum, pedagogy, and teachers' professional development. Educational policy, curriculum content, pedagogy and teachers' efficacy were major avenues for developing technology education that have been carefully addressed in the New Zealand context. This has resulted in positive progress toward implementing technology education in the school that was involved in this study. Despite the current work being based on only a small sample of available data (in particular, a

relatively small level of school-based observations), and although the situation of teaching technology education in the observed school in New Zealand was not perfect, the findings indicated positive features of the implementation of technology education that could inform other education contexts, such as in Saudi Arabia. Examples of problems in the New Zealand context, based on the data from the observed school, included issues related to talented and gifted students and gender biases, which were not given attention in the small number of New Zealand classrooms studied. The teachers who were surveyed had concerns about training and curriculum that might inform future changes. Therefore, this thesis provides a series of recommendations based on the ideas derived from the study, which should support further developments in teaching technology within Saudi Arabia. These focused on issues related to teacher training and resources, collaborative links with international partners, and a professional body to oversee work within the field in Saudi Arabia.

The unique contribution of the work in this thesis toward the development of new knowledge in the area of science and technology education focuses on its investigation of technology education in Saudi Arabia, which is a relatively new context of educational research. The value of the work is that it should help to reform science and technology education in Saudi Arabia. Therefore, this work is part of Saudi Arabia's ambition to seek experiences from other countries to reform its curricula. This study also lays out the path for those who want to know and write about this subject in Saudi Arabia. It would also encourage Saudis to work with the international technology education community to improve science and technology in schools.

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Appendix 1

Participant Information Sheet (PIS) to Technology Education teachers

Project title: TECHNOLOGY EDUCATION IN NEW ZEALAND AND SAUDI ARABIA CURRICULUM (A COMPARATIVE STUDY).

My name is Abbad Almutairi. I am a Ph.D. student at the College of Education, University of Canterbury. I will conduct this study that investigates Technology Education in New Zealand and Saudi Arabia curriculum (a comparative study). The key research question in this study will address **Should Technology Education be a subject in the primary curriculum of Saudi Arabia?** In this study I seek to understand Technology Education teachers' perspectives and investigate their experiences of teaching Technology Education. I am also interested in exploring how Technology Education is taught using good practice in New Zealand.

I am pleased to invite you as Technology Education teacher to be one of my study participants. In this project I will attend to your class several sessions to observe how Technology Education taught in a good practice and you will also be interviewed individually to provide me with your experience in teaching this subject that will be considered as major data in my study (The interview takes between 30-45 minutes). Also, I might interact with your students in some occasions to understand how they are receiving Technology Education (I will provide parents with PIS and consent form). You and I will discuss time and place of the interview that help to hold it in a convenient time for you.

The classroom observation will be recorded. However, you may request the recording to be stopped if you feel uncomfortable being recorded during the interview. You will be provided with a copy of interview transcript for review and approval. As the principal researcher, I will conduct and transcribe all the interviews. Your participation in this project is completely voluntary and you will be provided with a consent form. You may withdraw from the study any time. If you choose to withdraw, I will use my best endeavours to remove any of the information relating to you from the project, including any final publication, provided that this remains practically achievable.

All information will be treated in strictest confidence, you will remain anonymous where possible. All data will be kept by the researcher and any data that can identify you as participant will not be given to any other researchers or agency. As required by the University's research policy, at the completion of the project all information collected will be retained in secure storage for five years, after which it will be destroyed. The results of the study may be submitted for publication to national or international journals or presented at educational conferences. You may at any time ask for additional information or results from the study.

If you would like more information or have any questions about the research, you can contact me or my supervisors Professor Niki Davis (niki.davis@canterbury.ac.nz), Professor. John Everatt (john.everatt@canterbury.ac.nz) and Mr. Paul Snape (paul.snape@canterbury.ac.nz). If you have any concerns or complaints about this research, please contact ERHEC (see details below). If you are happy to take part you will need to **sign the consent form and return it to me** in the envelope provided **by** Day/Date/Month. Please retain this information sheet. Thank you for your consideration of this research project.

Abbad Almutairi (abbad-almutairi@pg.canterbury.ac.nz)

Appendix 2

Office Phone: (03) 3667001 extension: 45598.

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Project Title: TECHNOLOGY EDUCATION IN NEW ZEALAND AND SAUDI ARABIA
CURRICULUM (A COMPARATIVE STUDY).

Technology Education Teachers Consent Form

I understand the aims and purposes of the research study undertaken by **ABBAD ALMUTAIRI**.

- The study has been explained to me and I understand the information that was given to me on the information sheet.
- I am aware that my participation in this project is voluntary. I have had all questions answered to my satisfaction.
- I understand that my involvement will include an individual interview concerning my perceptions on teaching Technology Education.
- I understand (as a teacher in Technology Education) that I can withdraw from the study at any time, that I do not have to give any reason for withdrawing and that I understand my involvement in the project.
- I understand that all information will be treated in strictest confidence, that participants will remain anonymous and that no information that could identify me will be given to other researchers or agencies. I understand that all data from this research will be securely stored in password protected facilities and/or locked storage at the University of Canterbury for five years following the study.
- I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences; that the results of the study can be made available to me at my request and that I can request additional information at any time.
- I understand that interviews will be recorded and I can ask the recording to be stopped any time temporarily or permanently. I will be provided with a copy of interview transcript to check for accuracy.
- I have read the information sheet and consent form. I agree to participate in the study.

Name: _____

Signed: _____

Date: _____

Please return this completed consent form in the envelope provided by Day/Date/Month

Appendix 3

College of Education

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Participant Information Sheet (PIS) to Technology Education experts

Project title: TECHNOLOGY EDUCATION IN NEW ZEALAND AND SAUDI ARABIA CURRICULUM (A COMPARATIVE STUDY).

My name is Abbad Almutairi. I am a Ph.D. student at the College of Education, University of Canterbury. I will conduct this study that investigates Technology Education in New Zealand and Saudi Arabia curriculum (a comparative study). The key research question in this study is, **Should Technology Education be a subject in the primary curriculum of Saudi Arabia?** In this study I seek to understand Technology Education experts' perspectives and investigate their experiences of teaching Technology Education. I am also interested in exploring how Technology Education is taught using good practice in New Zealand.

As an expert of Technology Education, your experiences and perspectives in teaching the subject in primary schools are crucial to this study. It will help me to compare the situation of Technology Education in New Zealand and Saudi Arabia and then reconceptualise the concept of Technology Education in the Saudi curriculum. Thus, I will discuss this topic with you through an interview that is a basic tool in my study. It might take 30-45 minutes.

All information will be treated in strictest confidence; you will remain anonymous where possible. All data will be kept by the researcher and any data that can identify the you will not be given to any other researchers or agency. As required by the University's research policy, at the completion of the project all information collected will be retained in secure storage for five years, after which it will be destroyed. The results of the study may be submitted for publication to national or international journals or presented at educational conferences. Participants may at any time ask for additional information or results from the study.

If you would like more information or have any questions about the research, you can contact me or my supervisors Professor Niki Davis (niki.davis@canterbury.ac.nz), Professor. John Everatt (john.everatt@canterbury.ac.nz) and Mr. Paul Snape (paul.snape@canterbury.ac.nz). If you have any concerns or complaints about this research, please contact ERHEC (see details below). If you are happy to take part, kindly **sign the consent form and return it to me** in the envelope provided **by** Day/Date/Month. Please retain this information sheet. Thank you for your consideration of this research project.

Abbad Almutairi (abbad-almutairi@pg.canterbury.ac.nz)
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Appendix 4

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Project Title: TECHNOLOGY EDUCATION IN NEW ZEALAND AND SAUDI ARABIA
CURRICULUM (A COMPARATIVE STUDY).

Technology Education Experts Consent Form

I understand the aims and purposes of the research study undertaken by **ABBAD ALMUTAIRI**.

- The study has been explained to me and I understand the information that was given to me on the information sheet.
- I am aware that my participation in this project is voluntary. I have had all questions answered to my satisfaction.
- I understand that my involvement will include an individual interview concerning my perceptions and experience of Technology Education.
- I understand that I (as an expert of Technology Education) can withdraw from the study at any time, that I do not have to give any reason for withdrawing and that I understand my involvement in the project.
- I understand that all information will be treated in strictest confidence, that participants will remain anonymous and that no information that could identify me will be given to other researchers or agencies. I understand that all data from this research will be securely stored in password protected facilities and/or locked storage at the University of Canterbury for five years following the study.
- I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences; that the results of the study can be made available to me at my request and that I can request additional information at any time.
- I understand that interviews will be recorded and I can ask the recording to be stopped any time temporarily or permanently. I will be provided with a copy of interview transcript to check for accuracy.
- I have read the information sheet and consent form. I agree to participate in the study.

Name: _____

Signed: _____

Date: _____

Please return this completed consent form in the envelope provided by Day/Date/Month

Appendix 5A

Observation Process of teaching Technology Education in the classroom:

Session Number: *day:* *date:* *Time:* *Teacher: A*
Year: 6

Technology Education area: Control Topic: Robotics using sensors

Focus of learning of the unit:

<i>Technological practice</i>		<i>Technological knowledge</i>		<i>Nature of Technology:</i>	
Planning Brief development Outcome and evaluation		Technological modelling Technological products Technological systems		Characteristics of Technology Characteristics Of technological outcomes	

Lesson objectives:

1

2- 3-

Other comments:

<i>Number</i>	<i>Aspects</i>	<i>Comments</i>
1	<i>Learning Environment</i>	
	Teacher efficacy and Teacher knowledge of teaching	
	Classroom management	
	Unit plan	
	Type of pedagogy used	
	Teacher interaction with students	
	Students interaction with the teacher	
	Students collaborate with peers	

	The teacher provides opportunities to help students to use thinking skills in learning	
	Adequacy of Technology materials (resources) to meet lesson objectives and to develop technological outcomes	
2	Process of Teaching and learning	
	Relation of Materials used to lesson objectives	
	Identifying lesson objectives	
	Students learning styles (individually, collaboratively or both)	
	students' prior knowledge consideration	
	students' cultural consideration	
	Using Terms related to Technology Education by both the teacher and students such as: Technology, product, system, problem solving etc..	
	engaging students in an authentic task	
	Enhancing students' technological literacy through the lesson provided.	

Appendix 5 B

<i>Indicators of Progression for the components of Technological Knowledge (Level 3: Year 6)</i>		
2.3.2.1.1.1.1.1 Technological Modelling		Comments
Students can	<ol style="list-style-type: none"> 1) discuss examples to identify the different forms of functional models that were used to gather specific information about the suitability of design concepts 2) identify the benefits and limitations of functional modelling undertaken in particular examples 3) describe examples of particular prototypes that did not meet specifications. 4) explain why functional modelling and prototyping are both needed to support decision making when developing an outcome 	
The teacher supports students to	<ol style="list-style-type: none"> 1) provide them with the opportunity to explore different forms of functional modelling and guide students to gain insight into the different types of information that have been gathered 2) provide them with the opportunity to discuss how functional modelling informs decision making and guide them to identify the benefits and limitations of functional modelling in examples provided 3) provide them with the opportunity to understand that benefits include such things as reducing the risk of wasting time, money and materials and limitations arise due to the representational nature of modelling. That is, what is being tested is necessarily partial and therefore prototyping is required to fully test the outcome 4) provide them with the opportunity to discuss that specifications include both acceptability and feasibility considerations related to the outcome's fitness for purpose 5) provide them with the opportunity to 	

	<p>explore a range of examples of prototyping and guide them to gain insight into how appropriate information can be gained to evaluate a technological outcome's fitness for purpose against the specifications. Examples should include the modelling practices of technologists and should provide students with the opportunity to explore both successful prototypes and those that did not meet specifications.</p> <p>6) provide them with the opportunity to discuss the role of functional modelling and prototyping to develop an understanding of the importance of both in technological development.</p> <p>7) provide them with the opportunity to explore both successful prototypes and those that did not meet specifications.</p>	
2.3.2.1.1.1.1.2 Technological Products		Comments
Students can	<p>1) describe the properties of materials used in particular products that can be measured objectively;</p> <p>2) describe the properties of materials used in particular products that can be measured subjectively;</p> <p>3) describe how the properties combine to ensure the materials allow the product to be technically feasible and socially acceptable</p>	
The teacher supports students	<p>1) provide them with the opportunity to discuss that performance properties of materials can be measured objectively and subjectively. Subjective measurement is reliant on people's perception (tasty, evokes a sense of natural beauty, warm and inviting etc.) where as objective measurement is not (conductivity, UV resistance etc.). The fitness for purpose of a product relies on the material providing appropriate performance properties to ensure the product is technically feasible and</p>	

	<p>acceptable (safe, ethical, environmentally friendly, economically viable, etc. -as appropriate to particular products);</p> <p>2) provide them with a variety of technological products to explore and guide them to identify the performance properties of all the materials used, and to explain if these could be measured objectively or subjectively;</p> <p>3) provide them with a variety of technological products and guide them to explain how properties combine to make the product both technically feasible and socially acceptable</p>	
2.3.2.1.1.1.1.3 Technological Systems		Comments
Students can	<p>1) describe what 'black box' refers to within a technological system and the role of particular black boxes within technological systems;</p> <p>2) identify possible advantages and disadvantages of having black boxed transformations within particular technological systems;</p> <p>3) describe how the components, and how they are connected, allow particular systems to be technical feasible and socially acceptable;</p> <p>4) describe particular technological systems using specialised language and symbol conventions</p>	
The teacher supports students to	<p>1) provide them with the opportunity to investigate a range of technological systems and guide them to understand that technological systems do not require further human design decision making during the transformation process for the inputs to be transformed to outputs. That is, a technological system will produce particular outputs in an automated fashion once the inputs have initiated the transformation process;</p> <p>2) guide them to understand that a 'black box' is a term used to describe a part of a system where the inputs and outputs are known but the transformation process is not known;</p>	

	<ol style="list-style-type: none"> 3) provide examples of technological systems that contain unknown transformation processes (black boxes) and guide them to understand the role these play in terms of the advantages and/or disadvantages for developers and users; 4) provide opportunity for them to discuss that the fitness for purpose of a technological system relies on the selection of components, and how they are connected to ensure the system is technically feasible and acceptable (safe, ethical, environmentally friendly, economically viable, etc. -as appropriate to particular systems); 5) provide them with examples of how technological systems can be represented and guide them to interpret the specialised language and symbol conventions used; 6) provide them with opportunity to use specialised language and symbol conventions to represent technological systems to others. 	
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<i>Indicators of Progression for the components of Technological Practice (Level 3: Year 6)</i>		
Brief Development		Comments
Students can	<ol style="list-style-type: none"> 1) describe the physical and functional nature of the outcome they are going to produce and explain how the outcome will have the ability to address the need or opportunity 2) describe attributes for the outcome and identify those which are key for the development and evaluation of an outcome 	
The teacher	<ol style="list-style-type: none"> 1) provide the need or opportunity and develop 	

supports students to	<p>the conceptual statement in negotiation with the students</p> <ol style="list-style-type: none"> 2) guide them to describe the physical and functional nature of an outcome (e.g. what it looks like and what it can do) taking into account the need or opportunity, conceptual statements and resources available 3) guide them to identify the key attributes an appropriate outcome should have. Key attributes reflect those that are deemed essential for the successful function of the outcome. 	
Planning for Practice		Comments
Students can	<ol style="list-style-type: none"> 1) develop a plan that identifies key stages, and resources required to produce their outcome 2) review progress through the keys stages and resources used to date and use this to inform future planning decisions 	
The teacher supports students to	<ol style="list-style-type: none"> 1) ensure that there is a brief against which planning to develop an outcome can occur 2) provide them with an overview of what they will need to do during their technological practice and guide students to develop their own design process 	

	<ul style="list-style-type: none"> 3) provide a range of resources for them to select from and guide students to select those that will be appropriate for their outcome 4) guide them to review their plans at key points and reflect on progress to make informed decisions regarding earlier plans and resources. 	
Outcome Development and Evaluation		Comments
Students can	<ul style="list-style-type: none"> 1) describe design ideas (either through drawing, models and/or verbally) for potential outcomes 2) evaluate design ideas in terms of key attributes to develop a conceptual design for the outcome 3) select materials/components, based on their performance properties, for use in the production of the outcome 4) produce an outcome that addresses the brief 5) evaluate the final outcome against the key attributes to determine how well it met the need or opportunity 	
The teacher supports students to	<ul style="list-style-type: none"> 1) ensure that there is a brief with attributes against which a developed outcome can be evaluated 2) establish an environment that encourages and supports student innovation when generating design ideas 3) provide opportunities to develop drawing and modelling skills to 	

	<p>communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card etc.</p> <p>4) provide opportunity to develop knowledge and skills related to the performance properties of the materials/components students could use</p> <p>5) evaluate their outcome against the brief.</p>	
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Indicators of Progression for the components of Technological Practice (Level 3: Year 6)		
Brief Development		Comments
Students can	<p>3) describe the physical and functional nature of the outcome they are going to produce and explain how the outcome will have the ability to address the need or opportunity</p> <p>4) describe attributes for the outcome and identify those which are key for the development and evaluation of an outcome</p>	
The teacher supports students to	<p>4) provide the need or opportunity and develop the conceptual statement in negotiation with the students</p> <p>5) guide them to describe the physical and functional nature of an outcome (e.g. what it looks like and what it can do) taking into account the need or</p>	

	<p>opportunity, conceptual statements and resources available</p> <p>6) guide them to identify the key attributes an appropriate outcome should have. Key attributes reflect those that are deemed essential for the successful function of the outcome.</p>	
Planning for Practice		Comments
Students can	<p>3) develop a plan that identifies key stages, and resources required to produce their outcome</p> <p>4) review progress through the keys stages and resources used to date and use this to inform future planning decisions</p>	
The teacher supports students to	<p>5) ensure that there is a brief against which planning to develop an outcome can occur</p> <p>6) provide them with an overview of what they will need to do during their technological practice and guide students to develop their own design process</p> <p>7) provide a range of resources for them to select from and guide students to select those that will be appropriate for their outcome</p> <p>8) guide them to review their plans at key points and reflect on progress to make</p>	

	informed decisions regarding earlier plans and resources.	
Outcome Development and Evaluation		Comments
Students can	<ul style="list-style-type: none"> 6) describe design ideas (either through drawing, models and/or verbally) for potential outcomes 7) evaluate design ideas in terms of key attributes to develop a conceptual design for the outcome 8) select materials/components, based on their performance properties, for use in the production of the outcome 9) produce an outcome that addresses the brief 10) evaluate the final outcome against the key attributes to determine how well it met the need or opportunity 	
The teacher supports students to	<ul style="list-style-type: none"> 6) ensure that there is a brief with attributes against which a developed outcome can be evaluated 7) establish an environment that encourages and supports student innovation when generating design ideas 8) provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card etc. 9) provide opportunity to develop knowledge and skills related to the performance properties of the 	

	<p>materials/components students could use</p> <p>10) evaluate their outcome against the brief.</p>	
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Indicators of Progression for the components of the Nature of Technology (Level 3: Year 6)

2.3.2.1.1.1.1.4 Characteristics of Technology		Comments
Students can	<ol style="list-style-type: none"> 1) describe how societal and/or environmental issues can influence what people decided to make, how they would undertake planning, the selection of resources, and how they would make and test an outcome; 2) explain why particular technological outcomes have changed over time; 3) describe examples of how technology has impacted on the social world over time; 4) describe examples of how technology has impacted on the natural world over time; 5) identify that technological knowledge is knowledge that technologists agree is useful in ensuring a successful outcome 	
The teacher supports students to	<ol style="list-style-type: none"> 1) provide them with examples of different technologist's practice and guide them to identify how social and environmental issues could have influenced their decision making about; what should be made and why, how planning should be done and what resources should be used, how materials could be manipulated and tested, how outcomes should be evaluated, and manufacturing considerations; 2) provide them with the opportunity to explore a range of technologies and guide them to determine why 	

	<p>they have changed over time. Reasons for changes include such things as changing needs, fashions, attitudes, ethical and environmental stances etc., or the development of new materials, skills and knowledge;</p> <p>3) guide them to determine the impacts different technologies have had on society and/or the environment over time;</p> <p>4) provide them with opportunities to discuss technological knowledge as knowledge that technologists agree is important for the development of a successful outcome and that if this knowledge is useful for a number of situations it can be codified for quick reference. For example; material tolerances, ratios, dosage.</p>	
2.3.2.1.1.1.1.5 Characteristics of Technological Outcomes		Comments
Students can	<p>1) describe possible users and functions of a technological outcome based on clues provided by its physical attributes;</p> <p>2) describe examples of technological outcomes with different physical natures that have similar functional natures;</p> <p>3) describe examples of technological outcomes with different functional natures that have similar physical natures;</p> <p>4) explain why a technological outcome could be called a 'good' or 'bad' design</p>	
The teacher supports students to	<p>1) provide them with a range of technological outcomes with unknown functions to explore and guide them to make informed suggestions regarding who might use them and the possible function they could perform, as based on an exploration and analysis of their</p>	

	<p>physical nature;</p> <p>2) provide them with the opportunity to explore a range of technological outcomes that are similar in their functional nature but have differences in their physical natures and vice versa;</p> <p>3) to understand that the intended use and users, socio-cultural and physical locations all combine to determine how the physical and functional attributes can be best matched for optimum fitness for purpose. For example; a selection of brooms could be described as having similar functional attributes (clean an area by sweeping unwanted material to another location, able to be used while standing) but whether they are for a young child to sweep dust of the kitchen floor or for an adult to sweep water off driveways will mean quite different physical attributes will be decided upon to ensure the broom is fit for its purpose. Alternatively, a selection of brushes could be described as having similar physical natures (all have flexible bristles) but the way in which they are used will determine their functional nature as to whether they function to clean, act as a reservoir to spread a substance, or to separate something;</p> <p>4) guide them to understand the relationship between the physical and functional nature in a technological outcome. That is, the functional nature requirements set boundaries around the suitability of proposed physical nature options (for example a chair for a child will constrain the dimensions of the chair) and the physical nature options will set boundaries around what functional nature is feasible for a technological outcome at any time (for example heavy cast iron</p>	
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	<p>pots will not be suitable for everyday use by the elderly);</p> <p>5) guide them to understand that the judgment of a technological outcome as a 'good' or 'bad' is related to the match between its physical and functional nature, its intended user/s and the context they would normally use it in.</p>	
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Appendix 5 C

An observation sheet for teaching technology in year five and six in Saudi primary schools

Year: _____ session number: _____ date: _____ time: _____
 The lesson: _____

Lesson objectives:
 At the end of the lesson students should
 1-
 2-
 3-

General comments:

<i>Number</i>	<i>Aspects</i>	<i>Comments</i>
1	<i>Learning Environment</i>	
	Teacher efficacy and Teacher knowledge of teaching	
	Classroom management	
	Unit plan	
	Type of pedagogy used	
	Teacher interaction with students	
	Students interaction with the teacher	
	Students collaborate with peers	
	The teacher provides opportunities to help students to use thinking skills in learning	
	Adequacy of	

	Technology materials (resources) to meet lesson objectives and to develop technological outcomes	
2	Process of Teaching and learning	
	Relation of Materials used to lesson objectives	
	Identifying lesson objectives	
	Students learning styles (individually, collaboratively or both)	
	students' prior knowledge consideration	
	students' cultural consideration	
	Using Terms related to Technology Education by both the teacher and students such as: Technology, product, system, problem solving etc.	
	engaging students in an authentic task	
	Enhancing students' technological literacy through the lesson provided.	



Appendix 6

Abbad Almutairi

PhD student

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Dear, Science/ Technology teacher.

I am a supervisor of Technology Education at the Saudi Ministry of Education while studying for my Ph.D. at Canterbury University /College of Education. My Ph.D. thesis focuses on a comparison of Technology Education in primary schools in New Zealand and Saudi Arabia. It explores Technology as a separate subject in New Zealand and compares it with the Technology that is embedded into the General Science subject in the primary curriculum in Saudi Arabia. The result of this study could help to reconceptualise the concept of Technology Education in the Saudi primary curriculum by developing a clear framework for this subject. The following definition is included to avoid any misunderstanding or confusion with similar educational terms within this concept.

Technology Education means,

"intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities."

This subject has recently been introduced in some international curricula: for example, in England it is called "Design and Technology."

Please find attached a questionnaire that will help me understand your perception (as a teacher of Science and Technology) about teaching Technology in primary schools.

The questionnaire includes 26 statements and 3 open questions. There are five boxes opposite each statement. Please tick the most appropriate response.

Your name is not required but it would be helpful if you include your qualification and years of experience.

Please return the questionnaire via email, although you may, if you prefer, return a printed copy to the above address. In either case, your privacy will be protected and your name will not be mentioned in the research. Your responses will be used only for the purpose of this study.

Your help and your prompt response will be highly appreciated; your perception will support this study and will add value to it.

I look forward to receiving your response.

Yours faithfully

Qualification:

Years of experience:

No	Statements	Strongly agree	Agree	No Opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The technological revolution of the C21st requires governments to review curricula.					
2	The technological revolution will require schools to develop students' technological literacy.					
3	Including teaching technology in the primary curriculum will contribute in developing pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.					
4	Including teaching technology in primary schools will help in discovering pupils' professional capabilities.					
5	Primary school students need acquiring knowledge that helps them to keep pace with and to understand technological change.					
6	Primary students need to develop a wide range of knowledge and some basic technological skills.					
7	Primary school students need to develop an appreciation of the importance of technology to Saudi's economic development.					
8	Primary school pupils would benefit from their learning of designing technological products.					
9	Primary school students' need an awareness and understanding of the interaction between technology and society.					
10	It is important that primary students be creative and					

	innovative learners.					
11	It is important for students to recognize the environmental issues caused by technological developments.					
12	Hands on and practical activity contribute in making learning more fun.					
13	Without an understanding of technology students may feel powerless and threatened.					
14	Current primary curricula can contribute to prepare students who are creative and innovative.					
15	Current primary curricula can contribute to prepare students who are technologically literate.					
16	Current developed science curricula for primary schools can contribute to prepare students who are creative and innovative.					
17	Current developed science curricula for primary schools can contribute to prepare students who are technologically literate.					
18	Current developed science curricula for primary schools include several technological topics.					
19	I comprehend the importance of teaching technology in primary schools to produce technical generation.					
20	I find in myself the ability and the competence to teach technology in primary education.					
21	I comprehend the concept of technology amongst current primary science curricula.					
22	I can distinguish between technology concept and science concept as subjects in the educational curricula.					
23	I teach and help my students to design and produce simple					

	technical products.					
24	Increasing the number of technologists in Saudi would benefit further economic development.					

Do you think technological literacy can be developed within existing primary curricula?
Please comment.

Do you think technology can be taught as a separate subject or integrated with other subjects? Please comment.

What are the most important aspects of technological literacy?

Arabic Version

بسم الله الرحمن الرحيم

نموذج / ج

عزيزي وزميلي معلم العلوم

السلام عليكم ورحمة الله وبركاته وبعد:

أنا أحد منسوبي وزارة التربية والتعليم ومبتعث للدراسات العليا في جامعة كانتيربري في نيوزلندا ومجال دراستي هو (التربية التقنية)

ووجدت من خلال البحث أن هناك مادة دراسية تسمى التكنولوجيا "التقنية" والتي أصبحت تُدرس في المرحلة الابتدائية في كثير من دول العالم المتقدم وتُسمى أيضا في بعض الدول (التصميم والتقنية) ، وشدنتني هذه التجربة وقمت ببحثها والنظر في إمكانية نقل مثل هذه التجربة لمدارسنا. وقمت بتطبيق الدراسة الحالية بهدف بحث هذا الموضوع والحصول على درجة الدكتوراه في التعليم وعنوان دراستي هو (التقنية في مناهج المرحلة الابتدائية في نيوزلندا والسعودية ، دراسة مقارنة).

ورغبة مني كباحث رأيت أنه من المهم جدا أن أتعرف على وجهة نظركم حول هذه المادة من خلال تجربتكم في مجال تدريس العلوم والمرتبطة بلا شك بالتقنية من خلال إجابتكم على عبارات الاستبانة المرفقة وذلك بوضع علامة صح أمام العبارة المناسبة

وقبل الاجابة تفضلوا بقراءة التعريفات المبسطة لبعض مصطلحات الاستبانة حتى يكون لا يكون هناك إختلاف في فهم العبارة بيني وبينك.

١ التكنولوجيا (التقنية):

لا أعني بها الاجهزة الالكترونية مثل الحاسب الالى أو الراديو ، ولكن أعني بها النشاط البشري العقلي أو اليدوي والذي يشتمل على (التفكير، التخطيط، التصميم، التحليل ، التركيب ، الانتاج) وذلك من خلال استثمار العناصر المتوفرة في البيئة بهدف إنتاج (إختراع) شئ جديد أو تطوير شئ قديم مثل إختراع المذياع أو السيارة ، وذلك بهدف مساعدة الانسان للتغلب على المشاكل التي تواجهه في هذا العالم، وإشباع حاجاته وتحقيق متطلباته وتوفير الأمان له.

٢ محو أمية التقنية

في بعض المراجع العربية يسمى هذا المفهوم (التنوير أو التنور التكنولوجي) ، وهو تثقيف التلميذ تقنيا حتى يصبح قادرا على فهم مصطلحات التقنية وآليات عملها وكيفية التعامل معها ، وايضا مساعدة التلميذ لتصميم وعمل نماذج تقنية تتلائم مع مرحلة العمرية.

ملاحظة: يوجد في نهاية الاستبانة ٣ أسئلة مفتوحة فإذا كان لديك شرح أوسع و رأيت ان المساحة لا تكفي للتعليق فيمكنك التعليق خلف الورقة

أخوكم الباحث / طالب الدكتوراه بجامعة كانتيربري نيوزلندا

عباد بن صلاح المطيري

وفي حالة أي إستفسار يمكنكم التواصل معي على بريدي الجامعي

abbad.almutairi@pg.ac.nz

المؤهل: مدير/وكيل/معلم)
التخصص:
عدد سنوات الخبرة: العمل)

الرقم	العبارات	موافق بشدة	موافق	ليس لي رأي محدد	غير موافق	غير موافق بشدة
١	٢	٣	٤	٥	٦	٧
١	تدفع الثورة التقنية للقرن الواحد والعشرين الدول لمراجعة منهاجها الدراسية.					
٢	تفرض الثورة التقنية على المدارس تطوير ثقافة التلاميذ التقنية.					
٣	سوف يساهم إضافة تدريس التقنية في المرحلة الابتدائية في تطوير مقدرة التلاميذ لحل المشاكل التقنية من خلال تطبيق الأفكار العلمية والرياضية.					
٤	سوف يساعد إضافة تدريس التقنية في المرحلة الابتدائية في الكشف عن قدرات التلاميذ المهنية.					
٥	يحتاج تلاميذ المرحلة الابتدائية إمتلاك معرفة تساعد على مواكبة التغير التقني.					
٦	تلاميذ المرحلة الابتدائية بحاجة لتطوير بعض المعارف الأساسية والمهارات في التقنية.					
٧	يحتاج تلاميذ المرحلة الابتدائية لتطوير مستوى فهمهم وتقديرهم لأهمية التقنية في تطوير بلدهم.					
٨	سوف يكتسب تلاميذ المرحلة الابتدائية مهارات تقنية عند قيامهم بتصميم منتجات تقنية بسيطة.					
٩	يحتاج تلاميذ المرحلة الابتدائية إلى فهم التفاعل بين التقنية والمجتمع.					
١٠	من المهم أن يصبح تلاميذ المرحلة الابتدائية متعلمين مبدعين و مخترعين.					
١١	من المهم إدراك التلاميذ للقضايا البيئية الناتجة عن التطورات التقنية.					
١٢	تساهم الأنشطة العملية التقنية في جعل التعلم أكثر متعة.					
١٣	عدم فهم التلاميذ للتقنية قد يُشعرهم بالعجز والخوف من التعامل معها.					
١٤	يمكن أن تساهم مناهج المرحلة الابتدائية الحالية بشكل عام على إعداد					

					تلاميذ مبدعين ومخترعين.
١٥					يمكن أن تسهم مناهج المرحلة الابتدائية الحالية بشكل عام على إعداد تلاميذ مثقفين تقنياً.
١٦					يمكن أن تسهم مناهج العلوم المطوره الحالية في المرحلة الابتدائية على إعداد تلاميذ مبدعين ومخترعين.
١٧					يمكن أن تسهم مناهج العلوم المطورة الحالية في المرحلة الابتدائية على إعداد تلاميذ مثقفين تقنياً.
١٨					منهج العلوم الحالي المطور يحتوي علي مواضيع تقنية متعددة.
١٩					أستوعب أهمية تدريس التقنية في المرحلة الابتدائية في إنتاج جيل تقني.
٢٠					أجد في نفسي القدرة والكفاءة لتدريس التقنية في المرحلة الابتدائية.
٢١					أستوعب مفهوم التقنية ضمن مناهج العلوم الحالية في المرحلة الابتدائية.
٢٢					أستطيع أن أميز بين مفهوم التقنية ومفهوم العلوم كمواضيع في المناهج التربوية.
٢٣					أدرس وأساعد تلاميذي على تصميم وإنتاج منتجات تقنية بسيطة.
٢٤					ربما يفيد زيادة عدد التقنيين في السعودية في إحداث تطور اقتصادي سعودي أبعد في المستقبل.

هل تعتقد أن محو أمية التقنية يمكن تحقيقه من خلال مناهج المرحلة الابتدائية الحالية؟ وضح أكثر؟

هل تقترح تدريس مادة التقنية كمادة مستقلة ، أو مدمجة مع مادة أو مواد أخرى؟ وضح أكثر؟

في رأيك ماهي أهم الجوانب المهمة لمحو أمية التقنية ؟

Appendix 7



Abbad Almutairi

PhD student

Canterbury University

College of Education

Private Bag 4800, Christchurch 8140

New Zealand

Email: abbad.almutairi@pg.canterbury.ac.nz

Dear Professor, Doctor, Technology Trainer.

I am a supervisor of Technology Education at the Saudi Ministry of Education while studying for my Ph.D. at Canterbury University /College of Education. My Ph.D. thesis focuses on a comparison of Technology Education in primary schools in New Zealand and Saudi Arabia. It explores Technology as a separate subject in New Zealand and compares it with the Technology that is embedded into the General Science subject in the primary curriculum in Saudi Arabia. The result of this study could help to reconceptualise the concept of Technology Education in the Saudi primary curriculum by developing a clear framework for this subject. The following definition is included to avoid any misunderstanding or confusion with similar educational terms within this concept.

Technology Education means,

"intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities."

This subject has recently been introduced in some international curricula: for example, in England it is called "Design and Technology."

Please find attached a questionnaire that will help me understand your perception (as an expert in Science and Technology) about teaching Technology in primary schools. It may positively influence students' academic performances if they later study Science and Technology at secondary or tertiary education levels.

The questionnaire includes 15 statements and 3 open questions. There are five boxes opposite each statement. Please tick the most appropriate response.

Your name as a Science and Technology expert is not required but it would be helpful if you include your qualification, major field of study and years of experience.

Please return the questionnaire via email, although you may, if you prefer, return a printed copy to the above address. In either case, your privacy will be protected and your name will not be mentioned in the research. Your responses will be used only for the purpose of this study.

Your help and your prompt response will be highly appreciated; your perception will support this study and will add value to it.

I look forward to receiving your response.

Yours faithfully

Abbad Almutairi.

Qualification:

the Major:

Years of experience:

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The Technological Revolution of the 21st Century requires governments to review curricula.					
2	Students need to develop a wide range of technological literacy understanding.					
3	Providing primary school pupils with technological knowledge will help them to keep pace with and understand technological change.					
4	Including teaching technology in the primary curriculum will contribute in developing pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.					
5	Primary school pupils would benefit from their learning of designing technological products.					
6	Including teaching technology will offer hands-on learning that makes learning more fun.					
7	Without such an understanding of technology, students may feel powerless and threatened.					
8	Including technology in the Saudi primary curriculum will contribute in developing primary schools pupils' awareness and understanding of the interaction between technology and society.					
9	Including teaching technology in the curriculum will contribute in developing primary pupils' awareness of their responsibility towards environmental issues caused by technological development.					
10	Including teaching technology in the curriculum will contribute in					

	developing primary school pupils' appreciation of the importance of technology to Saudi's economic development.					
11	Saudi Arabia could benefit from a greater number of technologists.					
12	Including teaching technology in the Saudi primary curriculum will contribute to support teaching technology in universities, technology colleges, and technical vocational training institutes.					
13	Including teaching technology in the primary curriculum will help pupils to leave this stage acquiring enough basic skills in technology.					
14	Including teaching technology in primary schools will help in discovering pupils' professional capabilities.					
15	Science and technology are complementary to each other					

Do you think technological literacy can be developed within existing primary curricula?
Please comment.

Do you think technology can be taught as a separate subject or integrated with other subjects? Please comment.

What are the most important aspects of technological literacy?

Arabic Version

بسم الله الرحمن الرحيم

نموذج ب

عزيزي المدرب / الدكتور / البرفيسور

السلام عليكم ورحمة الله وبركاته وبعد:

أنا أحد منسوبي وزارة التربية والتعليم ومبتعث للدراسات العليا في جامعة كانتيربري في نيوزلندا ومجال دراستي هو (التربية التقنية) ،

ووجدت من خلال البحث أن هناك مادة دراسية تسمى التكنولوجيا "التقنية" والتي أصبحت تُدرس في المرحلة الابتدائية في كثير من دول العالم المتقدم وتُسمى أيضا في بعض الدول (التصميم والتقنية) ، وشددتني هذه التجربة وقمت ببحثها والنظر في إمكانية نقل مثل هذه التجربة لمدارسنا. وقمت بتطبيق الدراسة الحالية بهدف بحث هذا الموضوع والحصول على درجة الدكتوراه في التعليم وعنوان دراستي هو (التقنية في مناهج المرحلة الابتدائية في نيوزلندا والسعودية ، دراسة مقارنة).

و كباحث رأيت أنه من المهم جدا أن أتعرف على وجهة نظركم حول هذه المادة من خلال تجربتكم كخبراء/ مدربين في مجال التقنية والعلوم وكيف ترون أهمية تدريس مادة التصميم والتقنية في المرحلة الابتدائية وتأثيرها على الطلاب عند دراستهم المستقبلية والتحاقهم بال تخصصات التقنية في الكليات والجامعات التقنية من خلال إجابتكم على عبارات الاستبانة المرفقة وذلك بوضع علامة صح أمام كل العبارة المناسبة

وقبل الاجابة تفضلوا بقراءة التعريفات المبسطة لبعض مصطلحات الاستبانة حتى لا يكون هناك إختلاف في فهم العبارة بيني وبينك ،

١ التكنولوجيا (التقنية):

لا أعني بها الاجهزة الاليكترونية مثل الحاسب الالى أو الراديو ، ولكن أعني بها العمليات الفكرية المنظمة والتي تشمل (التفكير ، التخطيط، التصميم، التحليل ، التركيب ، الانتاج) وذلك من خلال إستثمار العناصر المتوفرة في البيئة بهدف إنتاج (إختراع) شئ جديد أو تطوير شئ قديم مثل إختراع المذيع أو السيارة ، وذلك بهدف مساعدة الانسان للتغلب على المشاكل التي تواجهه في هذا العالم ، وإشباع حاجاته وتحقيق متطلباته وتوفير الأمان له.

محو أمية التقنية

في بعض المراجع العربية يسمى هذا المفهوم (التنوير أو التنور التكنولوجي) ، وهو تثقيف التلميذ تقنيا حتى يصبح قادرا على فهم مصطلحات التقنية وآليات عملها وكيفية التعامل معها ، وايضا مساعدة التلميذ لتصميم وعمل نماذج تقنية تتلائم مع مرحلته العمرية.

ملاحظة: يوجد في نهاية الاستبانة ٣ أسئلة مفتوحة فاذا كان لديك شرح أوسع و رأيت ان المساحة لا تكفي للتعليق فيمكنك التعليق خلف الورقة.

أخوكم الباحث / طالب الدكتوراه بجامعة كانتيربري نيوزلندا

عباد بن صلاح المطيري

وفي حالة أي إستفسار يمكنكم التواصل معي على بريدي الجامعي

abbad.almutairi@pg.ac.nz

المؤهل:

التخصص:

عدد سنوات الخبرة:

الرقم	العبارات	موافق بشدة	موافق	ليس لي رأي محدد	غير موافق	غير موافق بشدة
		1	2	3	4	5
1	تدفع الثورة التقنية في القرن الحادي والعشرين الدول لمراجعة منهاجها الدراسية.					
2	التلاميذ اليوم بحاجة إلى تطوير مجال أوسع من المعرفة لفهم التقنية.					
3	تزويد تلاميذ المرحلة الابتدائية بالمعرفة التقنية سوف يساعدهم على مواكبة التغيرات التقنية.					
4	سوف يسهم إضافة تدريس التقنية في المناهج الابتدائية في تطوير مقدرة التلاميذ لحل المشاكل التقنية من خلال تطبيق الأفكار العلمية والرياضية.					
5	سوف يستفيد تلاميذ المرحلة الابتدائية من تعلمهم كيفية تصميم المنتجات التقنية.					
6	سوف يمنح إضافة تدريس التقنية التلميذ الفرصة للتعلم العملي الذي يجعل التعليم ممتعاً.					
7	عدم فهم التلاميذ للتقنية قد يُشعرهم بالعجز والخوف من التعامل معها.					
8	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير وعي التلاميذ وفهمهم للتفاعل بين التقنية والمجتمع.					
9	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير وعي التلاميذ بمسؤولياتهم تجاه القضايا البيئية الناتجة عن التطور التقني.					
10	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير تقدير التلاميذ لأهمية التقنية في تطوير الاقتصاد السعودي.					
11	ربما يفيد زيادة عدد التقنيين في السعودية في إحداث تطور إقتصادي سعودي أبعد في المستقبل.					
12	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في دعم تدريس التقنية في الجامعات و الكليات والمعاهد المهنية والتقنية.					
	سوف يساعد إضافة تدريس التقنية في					

					13 المرحلة الابتدائية التلاميذ للانتقال من هذه المرحلة وهم يمتلكون المهارات الأساسية في التقنية.
					14 سوف يساعد إضافة تدريس التقنية في المرحلة الابتدائية في الكشف عن قدرات التلاميذ المهنية.
					15 العلوم والتقنية يعتبر كلا منهما مكملًا للآخر.

هل تعتقد أن محو أمية التقنية يمكن تحقيقه من خلال مناهج المرحلة الابتدائية الحالية؟ وضح أكثر؟

هل تقترح تدريس مادة التقنية كمادة مستقلة ، أو مدمجة مع مادة أو مواد أخرى؟ وضح أكثر؟

في رأيك ماهي أهم الجوانب المهمة لمحو أمية التقنية

Appendix 8

Abbad Almutairi

PhD student

Canterbury University

College of Education

Private Bag 4800, Christchurch 8140

New Zealand

Email: abbad.almutairi@pg.canterbury.ac.nz

Dear Professor, Doctor, Technology Trainer.

I am a supervisor of Technology Education at the Saudi Ministry of Education while studying for my Ph.D. at Canterbury University /College of Education. My Ph.D. thesis focuses on a comparison of Technology Education in primary schools in New Zealand and Saudi Arabia. It explores Technology as a separate subject in New Zealand and compares it with the Technology that is embedded into the General Science subject in the primary curriculum in Saudi Arabia. The result of this study could help to reconceptualise the concept of Technology Education in the Saudi primary curriculum by developing a clear framework for this subject. The following definition is included to avoid any misunderstanding or confusion with similar educational terms within this concept.

Technology Education means,

"intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities."

This subject has recently been introduced in some international curricula: for example, in England it is called "Design and Technology."

Please find attached a questionnaire that will help me understand your perception (as an expert in Science and Technology) about teaching Technology in primary schools. It may positively influence students' academic performances if they later study Science and Technology at secondary or tertiary education levels.

The questionnaire includes 15 statements and 3 open questions. There are five boxes opposite each statement. Please tick the most appropriate response.



Your name as a Science and Technology expert is not required but it would be helpful if you include your qualification, major field of study and years of experience.

Please return the questionnaire via email, although you may, if you prefer, return a printed copy to the above address. In either case, your privacy will be protected and your name will not be mentioned in the research. Your responses will be used only for the purpose of this study.

Your help and your prompt response will be highly appreciated; your perception will support this study and will add value to it.

I look forward to receiving your response.

Yours faithfully

Abbad Almutairi.

Qualification:

the Major:

Years of experience:

No	Statements	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
		1	2	3	4	5
1	The Technological Revolution of the 21st Century requires governments to review curricula.					
2	Students need to develop a wide range of technological literacy understanding.					
3	Providing primary school pupils with technological knowledge will help them to keep pace with and understand technological change.					
4	Including teaching technology in the primary curriculum will contribute in developing pupils' capabilities to solve technological problems by applying scientific and mathematical ideas.					
5	Primary school pupils would benefit from their learning of designing technological products.					
6	Including teaching technology will offer hands-on learning that makes learning more fun.					
7	Without such an understanding of technology, students may feel powerless and threatened.					
8	Including technology in the Saudi primary curriculum will contribute in developing primary schools pupils' awareness and understanding of the interaction between technology and society.					
9	Including teaching technology in the curriculum will contribute in developing primary pupils' awareness of their responsibility towards environmental issues caused by technological development.					
10	Including teaching technology in the curriculum will contribute in					

	developing primary school pupils' appreciation of the importance of technology to Saudi's economic development.					
11	Saudi Arabia could benefit from a greater number of technologists.					
12	Including teaching technology in the Saudi primary curriculum will contribute to support teaching technology in universities, technology colleges, and technical vocational training institutes.					
13	Including teaching technology in the primary curriculum will help pupils to leave this stage acquiring enough basic skills in technology.					
14	Including teaching technology in primary schools will help in discovering pupils' professional capabilities.					
15	Science and technology are complementary to each other					

Do you think technological literacy can be developed within existing primary curricula?
Please comment.

Do you think technology can be taught as a separate subject or integrated with other subjects? Please comment.

What are the most important aspects of technological literacy?

Arabic Version

بسم الله الرحمن الرحيم

نموذج ب

عزيزي المدرب / الدكتور / البرفيسور

السلام عليكم ورحمة الله وبركاته وبعد:

أنا أحد منسوبي وزارة التربية والتعليم ومبتعث للدراسات العليا في جامعة كانتيربري في نيوزلندا ومجال دراستي هو (التربية التقنية) ،
ووجدت من خلال البحث أن هناك مادة دراسية تسمى التكنولوجيا "التقنية" والتي أصبحت تُدرس في المرحلة الابتدائية في كثير من دول العالم المتقدم وتُسمى أيضا في بعض الدول (التصميم والتقنية) ، وشدنتني هذه التجربة وقمت ببحثها والنظر في إمكانية نقل مثل هذه التجربة لمدارسنا. وقمت بتطبيق الدراسة الحالية بهدف بحث هذا الموضوع والحصول على درجة الدكتوراه في التعليم وعنوان دراستي هو (التقنية في مناهج المرحلة الابتدائية في نيوزلندا والسعودية ، دراسة مقارنة).

و كباحث رأيت أنه من المهم جدا أن أتعرف على وجهة نظركم حول هذه المادة من خلال تجربتكم كخبراء/ مدربين في مجال التقنية والعلوم وكيف ترون أهمية تدريس مادة التصميم والتقنية في المرحلة الابتدائية وتأثيرها على الطلاب عند دراستهم المستقبلية والتحاقهم بال تخصصات التقنية في الكليات والجامعات التقنية من خلال إجابتكم على عبارات الاستبانة المرفقة وذلك بوضع علامة صح أمام كل العبارة المناسبة

وقبل الاجابة تفضلوا بقراءة التعريفات المبسطة لبعض مصطلحات الاستبانة حتى لا يكون هناك إختلاف في فهم العبارة بيني وبينك ،

١ التكنولوجيا (التقنية):

لا أعني بها الاجهزة الاليكترونية مثل الحاسب الالى أو الراديو ، ولكن أعني بها العمليات الفكرية المنظمة والتي تشمل (التفكير ، التخطيط ، التصميم ، التحليل ، التركيب ، الانتاج) وذلك من خلال إستثمار العناصر المتوفرة في البيئة بهدف إنتاج (إختراع) شئ جديد أو تطوير شئ قديم مثل إختراع المذيع أو السيارة ، وذلك بهدف مساعدة الانسان للتغلب على المشاكل التي تواجهه في هذا العالم ، وإشباع حاجاته وتحقيق متطلباته وتوفير الأمان له.
محو أمية التقنية

في بعض المراجع العربية يسمى هذا المفهوم (التنوير أو التنور التكنولوجي) ، وهو تثقيف التلميذ تقنيا حتى يصبح قادرا على فهم مصطلحات التقنية وآليات عملها وكيفية التعامل معها ، وايضا مساعدة التلميذ لتصميم وعمل نماذج تقنية تتلائم مع مرحلته العمرية.

ملاحظة: يوجد في نهاية الاستبانة ٣ أسئلة مفتوحة فاذا كان لديك شرح أوسع و رأيت ان المساحة لا تكفي للتعليق فيمكنك التعليق خلف الورقة.

أخوكم الباحث / طالب الدكتوراه بجامعة كانتيربري نيوزلندا

عباد بن صلاح المطيري

وفي حالة أي إستفسار يمكنكم التواصل معي على بريدي الجامعي

abbad.almutairi@pg.ac.nz

المؤهل:

التخصص:

عدد سنوات الخبرة:

الرقم	العبارات	موافق بشدة	موافق	ليس لي رأي محدد	غير موافق	غير موافق بشدة
		1	2	3	4	5
1	تدفع الثورة التقنية في القرن الحادي والعشرين الدول لمراجعة منهاجها الدراسية.					
2	التلاميذ اليوم بحاجة إلى تطوير مجال أوسع من المعرفة لفهم التقنية.					
3	تزويد تلاميذ المرحلة الابتدائية بالمعرفة التقنية سوف يساعدهم على مواكبة التغيرات التقنية.					
4	سوف يسهم إضافة تدريس التقنية في المناهج الابتدائية في تطوير مقدرة التلاميذ لحل المشاكل التقنية من خلال تطبيق الأفكار العلمية والرياضية.					
5	سوف يستفيد تلاميذ المرحلة الابتدائية من تعلمهم كيفية تصميم المنتجات التقنية.					
6	سوف يمنح إضافة تدريس التقنية للتلميذ الفرصة للتعلم العملي الذي يجعل التعليم ممتعاً.					
7	عدم فهم التلاميذ للتقنية قد يُشعرهم بالعجز والخوف من التعامل معها.					
8	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير وعي التلاميذ وفهمهم للتفاعل بين التقنية والمجتمع.					
9	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير وعي التلاميذ بمسؤولياتهم تجاه القضايا البيئية الناتجة عن التطور التقني.					
10	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في تطوير تقدير التلاميذ لأهمية التقنية في تطوير الاقتصاد السعودي.					
11	ربما يفيد زيادة عدد التقنيين في السعودية في إحداث تطور إقتصادي سعودي أبعد في المستقبل.					
12	سوف يسهم إضافة تدريس التقنية في مناهج المرحلة الابتدائية في دعم تدريس التقنية في الجامعات و الكليات والمعاهد المهنية والتقنية.					
	سوف يساعد إضافة تدريس التقنية في					

					13 المرحلة الابتدائية التلاميذ للانتقال من هذه المرحلة وهم يمتلكون المهارات الأساسية في التقنية.
					14 سوف يساعد إضافة تدريس التقنية في المرحلة الابتدائية في الكشف عن قدرات التلاميذ المهنية.
					15 العلوم والتقنية يعتبر كلا منهما مكملًا للآخر.

هل تعتقد أن محور أمية التقنية يمكن تحقيقه من خلال مناهج المرحلة الابتدائية الحالية؟ وضح أكثر؟

هل تقترح تدريس مادة التقنية كمادة مستقلة ، أو مدمجة مع مادة أو مواد أخرى؟ وضح أكثر؟

في رأيك ماهي أهم الجوانب المهمة لمحو أمية التقنية

Appendix 9:

Years	Objectives of science and technology
Year 6	<p>The philosophy of the textbook used in this year focuses on providing a student with the practical methodology of thinking and work. It also provides him with thinking and practical skills that enable him to:</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write - draw - make models, and - connect knowledge with life. <p>In addition, the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help strengthen the scientific knowledge of the student and provide him with practical skills in science and technology. It may also develop a tendency and attitude towards knowledge and scientists.</p>
Year 5	<p>The philosophy of this textbook focuses on providing a student with the practical methodology of thinking and work. It also provides him with thinking and practical skills that enable him to:</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write - draw - make models, and - connect knowledge with life.

	<p>In addition, the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help to strengthen the scientific knowledge of the student and to provide him with practical skills in science and technology. This additional booklet could help develop a student's tendency and attitude towards knowledge and scientists.</p>
Year 4	<p>The philosophy of this textbook focuses on providing a student with the practical methodology of thinking and work. Also proving him with thinking and practical skills that enable him to</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write - draw - make models - connect knowledge with life <p>In addition, the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help to strengthen the scientific knowledge of the student and to provide him with practical skills in science and technology. In addition to that to develop his tendency and attitude towards knowledge and scientists.</p>
Year 3	<p>The philosophy of this textbook focuses on providing a student with the practical methodology of thinking and work. Also proving him with thinking and practical skills that enable him to</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write

	<ul style="list-style-type: none"> - draw - make models - connect knowledge with life <p>In addition, the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help to strengthen the scientific knowledge of the student and to provide him with practical skills in science and technology. In addition to that to develop his tendency and attitude towards knowledge and scientists</p>
Year 2	<p>The philosophy of this textbook focuses on providing a student with the practical methodology of thinking and work. Also proving him with thinking and practical skills that enable him to</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write - draw - make models - connect knowledge with life <p>in addition the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help to strengthen the scientific knowledge of the student and to provide him with practical skills in science and technology. In addition, the booklet provides the students with research and inquiry skills in science, also to develop his tendency and attitude towards knowledge and scientists</p>
Year	The philosophy of this textbook focuses on providing a student with the practical

1	<p>methodology of thinking and work. Also proving him with thinking and practical skills that enable him to</p> <ul style="list-style-type: none"> - read pictures - scientifically read and write - draw - make models - connect knowledge with life <p>in addition the philosophy of this textbook attempts to link science and technology with other disciplines such as mathematics, arts, health and society. There is an additional exercise booklet that could help to strengthen the scientific knowledge of the student and to provide him with practical skills in science and technology. In addition, the booklet provides the students with research and inquiry skills in science, also to develop his tendency and attitude towards knowledge and scientists</p>
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Appendix 10: Science textbooks content in primary education.

Years	Content of science and technology in Term One	Content of science and technology in Term Two
Year 6	<p>Has the following units, sections and lessons:</p> <p>Unit One: Diversity of life</p> <p>Section One: Cells</p> <p>Lesson One: Cell theory</p> <p>Lesson Two: Plant and animal cells</p> <p>Reviewing Section One</p> <p>Section Two: Cell and genetics</p> <p>Lesson One: cell division</p> <p>Lesson Two: genetics and objectives</p> <p>Science and Mathematics</p> <p>Reviewing Section Two</p> <p>Unit Two: Life Processes</p> <p>Section Three: life processes in micro living creatures</p> <p>Lesson One: life processes in plants</p>	<p>Has the following units, sections and lessons:</p> <p>Unit Four: Space</p> <p>Section Seven: the Sun, Earth and Moon</p> <p>Lesson One: the Sun and Earth systems</p> <p>Lesson Two: their systems</p> <p>Reviewing Section Seven</p> <p>Section Eight: Astronomy</p> <p>Lesson One: the solar system</p> <p>Lesson Two; stars and galaxies</p> <p>Science and Mathematics –</p> <p>Reviewing Section Eight</p> <p>Unit Five: the material</p> <p>Section Nine: the material classification</p> <p>Lesson One: the physical properties of the material</p> <p>Lesson Two: water and mixtures</p> <p>Work as scientists – Reviewing</p>

<p>Lesson Two: life process in micro creatures.</p> <p>Scientific writing: marine life.</p> <p>Reviewing Section Three.</p> <p>Section Four: life processes in animals.</p> <p>Lesson One: digestion, elimination, breathing and circulation systems.</p> <p>Lesson two: movement and sensation.</p> <p>Work as scientists</p> <p>Reviewing section four.</p> <p>Unit three: ecosystems and their resources.</p> <p>Section five: ecosystems</p> <p>Lesson one: Food chains and energy hierarchy</p> <p>Lesson two: comparison of the ecosystems.</p> <p>Scientific writing: field trip to Redah conservation.</p> <p>Reviewing section five.</p> <p>Section six: protection of Earth</p>	<p>Section Nine</p> <p>Section Ten: chemical properties changes</p> <p>Lesson One: chemical changes</p> <p>Lesson Two: chemical properties – scientific writing- Reviewing Section Ten</p> <p>Unit Six: Energy and power</p> <p>Section Eleven: using power</p> <p>Lesson One: movement</p> <p>Lesson Two: Powers and movement – scientific careers – Reviewing section eleven</p> <p>Section twelve:</p> <p>Electromagnetic</p> <p>Lesson one: electricity</p> <p>Lesson two: Magnetic</p> <p>Science and Mathematics – Reviewing section twelve</p> <p>References for the student</p> <p>Measurement</p> <p>Organizing data</p> <p>Periodic table</p>
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	<p>resources</p> <p>Lesson one: soil</p> <p>Lesson two: resources protection</p> <p>Scientific reading: clean energy.</p> <p>Reviewing section six.</p> <p>References for the student</p> <p>Scientific tools- human systems-terminology.</p>	<p>Terminology</p>
Year 5	<p>Unit one: diversity of life</p> <p>Section one: Realm of living creatures.</p> <p>Lesson one: Living creatures: classification.</p> <p>Lesson two: The plants</p> <p>Scientific writing: Saving water based on the Cactus plant method.</p> <p>Reviewing section one.</p> <p>Section two: parents and children</p> <p>Lesson one: propagation</p> <p>Lesson two: life cycles</p> <p>Focusing on scientific skills</p> <p>Reviewing section two</p>	<p>Unit four: The weather</p> <p>Section seven: Weather patterns</p> <p>Lesson one: Weather and atmosphere</p> <p>Lesson two: clouds and rain.</p> <p>Focusing on skills.</p> <p>Reviewing section seven.</p> <p>Section eight: storms and climate</p> <p>Lesson one: storms</p> <p>Lesson two: climate</p> <p>Science and mathematics.</p> <p>Reviewing section eight.</p> <p>Unit five: Materials</p> <p>Section nine: comparing types of</p>

	<p>Unit two: ecosystems</p> <p>Section three: interactions in the ecosystems</p> <p>Lesson one: relations in the ecosystems.</p> <p>Lesson two: adaptation and survival</p> <p>Scientific writing: Story; the snake and the desert rat.</p> <p>Reviewing section three.</p> <p>Section four: cycles and changes in the ecosystems.</p> <p>Lesson one: cycles in ecosystems</p> <p>Lesson two: changes in ecosystems</p> <p>Scientific vocations: horticulture</p> <p>Reviewing section four.</p> <p>Unit three: Earth and its resources.</p> <p>Section five: our changing Earth</p> <p>Lesson one: Earth surface: landmarks.</p> <p>Lesson two: the impact factors on Earth.</p>	<p>material.</p> <p>Lesson: The Elements</p> <p>Lesson two: metal, non-metal, and semi-metal</p> <p>Work as scientists.</p> <p>Reviewing section nine.</p> <p>Section ten: physical and chemical changes of the material.</p> <p>Lesson one: changes of the material conditions.</p> <p>Lesson one: changes of material conditions.</p> <p>Lesson two: compounds and the chemical changes.</p> <p>Science and mathematics.</p> <p>Reviewing section ten.</p> <p>Unit six: powers and energy</p> <p>Section eleven: energy and simple machines.</p> <p>Lesson one: work and energy</p> <p>Lesson two: simple machines</p> <p>Scientific vocations: mechanical engineer/ automobile mechanic.</p> <p>Reviewing section eleven.</p>
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	<p>Work as scientists.</p> <p>Reviewing section five.</p> <p>Section six: Earth resources preservation.</p> <p>Lesson one: fossils and energy</p> <p>Lesson two: Air and Water</p> <p>Scientific vocations: Maps; drawing and well sinking.</p> <p>Reviewing section six.</p> <p>Terminology.</p>	<p>Section twelve: sound and light</p> <p>Lesson one: Sound</p> <p>Lesson two: Light</p> <p>Science and mathematics</p> <p>Reviewing section twelve.</p> <p>References for the students</p> <p>Measurement</p> <p>Data</p> <p>Terminology</p>
Year 4	<p>Work as scientists</p> <p>Scientific method</p> <p>Scientific skills</p> <p>Safety instructions</p> <p>Unit one: living creatures</p> <p>Section one: Realms of living creatures</p> <p>Lesson one: Cells</p> <p>Lesson two: living creatures classification.</p> <p>Focusing on skills: observation</p>	<p>Unit four: Space</p> <p>Section five: solar system and space</p> <p>Lesson one: The Earth, Sun and Moon</p> <p>Lesson two: The solar system</p> <p>Scientific reading: Muslims and astronomy</p> <p>Reviewing section five.</p> <p>Unit five: the material</p> <p>Section six: measuring material and its change</p> <p>Lesson one: Measurement</p>

	<p>Reviewing section one</p> <p>Section two: Planet Realm</p> <p>Lesson one: invertebrate animals</p> <p>Lesson two: vertebrate animals.</p> <p>Lesson three: systems of animal bodies</p> <p>Science and mathematics: animal protection.</p> <p>Reviewing section two.</p> <p>Unit two: ecosystems</p> <p>Section three: exploring ecosystems</p> <p>Lesson one: introduction of ecosystem</p> <p>Lesson two: relationships in ecosystems</p> <p>Lesson three: changes in ecosystems</p> <p>Scientific reading: Saudi National Commission for Wildlife Conservation and Development.</p> <p>Reviewing section three.</p> <p>Unit three: Earth and its resources</p>	<p>Lesson two: How is the material changing?</p> <p>Lesson three: mixtures</p> <p>Focusing on skills: using variables</p> <p>Reviewing section six.</p> <p>Unit six: powers and energy</p> <p>Section seven: powers</p> <p>Lesson one: powers and movement</p> <p>Lesson two: change the movement</p> <p>Science and mathematics: friction force.</p> <p>Reviewing section seven</p> <p>Section eight: energy</p> <p>Lesson one: Heat</p> <p>Lesson two: electricity</p> <p>Lesson three: Magnetism</p> <p>Work as scientists</p> <p>References for the student</p> <p>Measurement</p> <p>Scientific tools</p> <p>Organizing data</p> <p>Terminology</p>
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	<p>Section four: resources of Earth</p> <p>Lesson one: materials and rocks</p> <p>Lesson two: water</p> <p>Scientific writing: water conservation</p> <p>Reviewing section four.</p> <p>References for the student</p> <p>Human body systems</p> <p>Food and health</p> <p>Terminology</p>	
Year 3	<p>Scientific method</p> <p>Scientific skills</p> <p>Safety instructions</p> <p>Unit one: Living creatures</p> <p>Section one: Knowing Living creatures</p> <p>Lesson one: Living creatures and their needs</p> <p>Lesson two: plants and their parts.</p> <p>Work as scientists.</p> <p>Reviewing section one</p> <p>Section two: Living creatures:</p>	<p>Unit four: Weather and climate</p> <p>Section seven: Weather and its vagaries</p> <p>Lesson one: weather elements</p> <p>Lesson two: Vagaries of the weather.</p> <p>Vocations related to science.</p> <p>Reviewing section seven.</p> <p>Section eight: water and climate cycle.</p> <p>Lesson one: water cycle</p> <p>Lesson two: climate and seasons</p> <p>Science and mathematics.</p> <p>Reviewing section eight.</p>

<p>growing and changes</p> <p>Lesson one: plants life cycles</p> <p>Lesson two: animals life cycles.</p> <p>Vocations related to science.</p> <p>Reviewing section two.</p> <p>Unit two: ecosystem</p> <p>Section three: living creatures in ecosystem</p> <p>Lesson one: food chains and networks</p> <p>Lesson two: adaptation.</p> <p>Focusing on skills.</p> <p>Reviewing section three</p> <p>Section four: Changes in ecosystems</p> <p>Lesson one: changes impact on living creatures</p> <p>Lesson two: Living creatures change their environments.</p> <p>Scientific writing: Protecting living creatures from extinction.</p> <p>Reviewing section four.</p> <p>Unit three: Earth and its resources</p>	<p>Unit five: the materials</p> <p>Section nine: materials observation</p> <p>Lesson one: the material and how it is measured.</p> <p>Lesson two: solid, liquid and gaseous materials.</p> <p>Focusing on the skills.</p> <p>Reviewing section nine.</p> <p>Section ten: Changes of material</p> <p>Lesson one: physical changes</p> <p>Lesson two: chemical changes</p> <p>Scientific reading.</p> <p>Reviewing section ten.</p> <p>Section eleven: location and movement</p> <p>Lesson one: site the powers</p> <p>Lesson two: the powers.</p> <p>Work as scientists</p> <p>Reviewing section eleven.</p> <p>Section twelve: Some types of energy</p> <p>Lesson one: the sound</p> <p>Lesson two: the light.</p>
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	<p>Section five: Earth is changing</p> <p>Lesson one: The sudden changes of Earth</p> <p>Lesson two: weathering and erosion.</p> <p>Scientific reading: science and technology and society: landslide.</p> <p>Reviewing section five.</p> <p>Section six: Earth resources</p> <p>Lesson one: soil</p> <p>Lesson two: Fossils and Fossil fuels</p> <p>Scientific Reading: Science history Renewable energy resources.</p> <p>Reviewing section six.</p> <p>References for the student</p> <p>Human body systems</p> <p>Health</p> <p>Terminology</p>	<p>Work as scientists</p> <p>Reviewing section twelve</p> <p>References for the student</p> <p>Measurement</p> <p>Scientific tools</p> <p>Organizing data</p> <p>Terminology</p>
Year 2	<p>Unit one: plants and animals</p> <p>Section one: plants.</p>	<p>Unit four: Climate and the sky.</p> <p>Section seven: Climate observation.</p>

<p>Lesson one: needs of plants.</p> <p>Lesson two: plants generate new plants.</p> <p>Science and technology and society: scientific reading: human needs for plants.</p> <p>Reviewing section one.</p> <p>Section two: animals.</p> <p>Lesson one: animals groups.</p> <p>Lesson two: animals grow and change.</p> <p>Science and technology and society: scientific reading; snakes.</p> <p>Reviewing section two.</p> <p>Unit two: habitations.</p> <p>Section three: view of habitations.</p> <p>Lesson one: locations of life</p> <p>Lesson two: food chains.</p> <p>Scientific reading: changes of habitations.</p> <p>Reviewing section three.</p> <p>Section four: types of habitations.</p>	<p>Lesson one: Climate.</p> <p>Lesson two: Water cycle.</p> <p>Scientific writing: a rainy day.</p> <p>Reviewing section seven.</p> <p>Section eight: Earth and space.</p> <p>Lesson one: night and day</p> <p>Lesson two: causes of the four seasons.</p> <p>Scientific reading: the stars at night.</p> <p>Reviewing section eight.</p> <p>Unit five: Material.</p> <p>Section nine: view on the material</p> <p>Lesson one: material description</p> <p>Lesson two: solid materials</p> <p>Lesson three: liquid and gas.</p> <p>Science and mathematics: whichever is bigger in volume?</p> <p>Reviewing section nine.</p> <p>Section ten: changes of Material.</p> <p>Lesson one: the material is changing.</p> <p>Lesson two: change of the condition of the material.</p>
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	<p>Lesson one: Hot and cold deserts.</p> <p>Lesson two: Forests.</p> <p>Science and mathematics: graphical representation of stream animals.</p> <p>Reviewing section four.</p> <p>Unit three: our Earth.</p> <p>Section five: land and water.</p> <p>Lesson one: land.</p> <p>Lesson two: Water on the Earth.</p> <p>Scientific reading: Earth's changeable surface.</p> <p>Reviewing section five.</p> <p>Section six: materials of the earth.</p> <p>Lesson one: rocks and minerals.</p> <p>Lesson two: soil.</p> <p>Science and technology and society: scientific reading: using the natural materials.</p> <p>Reviewing section six.</p> <p>References for the student</p> <p>Human body</p> <p>Health</p>	<p>Science and technology and society: scientific reading: how to make wax pens?</p> <p>Reviewing section ten.</p> <p>Unit six: powers and energy.</p> <p>Section eleven: the powers.</p> <p>Lesson one: the powers move things.</p> <p>Lesson two: magnetism.</p> <p>Scientific reading: the simple machines simplify works.</p> <p>Reviewing section eleven.</p> <p>Section twelve: using energy.</p> <p>Lesson one: heat.</p> <p>Lesson two: discovering electricity.</p> <p>Science and technology and society: scientific reading: generating electricity.</p> <p>Reviewing section twelve.</p> <p>References for the student</p> <p>Measurement</p> <p>Scientific tools</p> <p>Safety</p> <p>Terminology</p>
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	<p>Safety</p> <p>Terminology</p>	
Year 1	<p>Unit one: Plants around us</p> <p>Section one: plants are creatures</p> <p>Lesson one: Living creatures</p> <p>Lesson two: plants and their parts</p> <p>Science and technology and society: scientific reading: Mango agriculture.</p> <p>Reviewing section one.</p> <p>Section two: Plants are growing and changing</p> <p>Lesson one: plant growth</p> <p>Lesson two: plants live in different areas.</p> <p>Science and mathematics: variety of seeds</p> <p>Reviewing section two.</p> <p>Unit two: animals and their habitats</p> <p>Section three: animals around us.</p> <p>Lesson one: types of animals</p> <p>Lesson two: animals and their</p>	<p>Unit four: Climate.</p> <p>Section six: climate and seasons.</p> <p>Lesson one: climate around us.</p> <p>Lesson two: the four seasons.</p> <p>Science and mathematics: drawing bars to represent the activities.</p> <p>Reviewing section six.</p> <p>Unit five: the material.</p> <p>Section seven: the materials around us.</p> <p>Lesson one: materials properties.</p> <p>Lesson two: solid materials.</p> <p>Lesson three: liquid and gas.</p> <p>Science and technology and society: scientific reading: the construction unit.</p> <p>Reviewing section seven.</p> <p>Section eight: The material is changing.</p> <p>Lesson one: The material is changing.</p> <p>Lesson two: mixtures.</p>

<p>needs</p> <p>Scientific reading: know more about animals.</p> <p>Reviewing section three.</p> <p>Section four: places to live</p> <p>Lesson one: habitats on land</p> <p>Lesson two: habitats under the water.</p> <p>Science and mathematics: Count the legs.</p> <p>Reviewing section four.</p> <p>Unit three: Our Earth</p> <p>Section five: Earth resources</p> <p>Lesson one: Earth resources</p> <p>Lesson two: benefit from Earth's resources.</p> <p>Lesson three: Earth resource protection</p> <p>Scientific reading: water conservation.</p> <p>Reviewing section five.</p> <p>References for the student</p> <p>Safety instructions</p>	<p>Lesson three: vocations related to science: the baker.</p> <p>Reviewing section eight.</p> <p>Unit six: the movement and the energy</p> <p>Section nine: the movement</p> <p>Lesson one: location and movement.</p> <p>Lesson two: push and withdrawal.</p> <p>Focusing on skills: inquiry and deduction skills.</p> <p>Reviewing section nine.</p> <p>Section ten: energy.</p> <p>Lesson one: energy and heat.</p> <p>Lesson two: light and sound.</p> <p>Science and mathematics: the coloured glasses.</p> <p>Reviewing section ten.</p> <p>References for the student</p> <p>Measurement</p> <p>Scientific tools</p> <p>Terminology</p>
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	Terminology	
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Appendix 11:

Teachers' questions

- 1) Technology education has recently been taught as a separate subject in some countries, such as New Zealand. Do you think this is good idea, if so why?
- 2) Do your students enjoy science and technology education?
- 3) What is the relationship between science and technology?
- 4) What resources do you use to teach science and technology education?
- 5) Can you explain the current situation regarding technology education in the Saudi curriculum?
- 6) Do you face any difficulties in teaching technology? If yes, what are they?
- 7) Could you tell me about the professional development of science technology education? Is it important for science technology education teachers? If so, how is it planned and implemented?

Appendix 12:

Experts' questions

- 1) Technology education has recently been taught as a separate subject in countries such as New Zealand. Do you think this is good idea and, if so, why?
- 2) Can you explain the current concept of technology education in Saudi Arabia?
- 3) What do you think about integrating technology education with other subjects such as science?
- 4) Do you believe there is a gap between theory and practice in terms of teaching technology education?
- 5) What suggestions do you have for improving teaching technology education in Saudi Arabia?